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Typological differentiation and status of Natura 2000 mire habitats in Poland

L. WOLEJKO, M. HERBICHOWA & J. POTOCKA

Abstract: The chapter presents the typological differentiation and status of Natura 2000 mire habitats in Poland. In spite of universal definitions and descriptions (INTERPRETATION MANUAL... 1996), there is a certain liberty in the local understanding of the particular habitat in each of the member states. Among the 76 habitat types included on the Natura 2000 list for Poland (HERBICH 2004) there are six habitats of living mires, namely: Active raised bogs, degraded raised bogs, still capable of regeneration, transition mires and quaging bogs, depressions on peat substrates, lake-chalk mires and basiphilous mires. Each of the mire habitats has been defined and characterised in respect of the geographical distribution in Poland, ecological features, vegetation dynamics, state of preservation, and protection requirements. The implementation of the Natura 2000 system created new opportunities for mires in Poland. Due to European Community's interest these valuable and threatened ecosystems have achieved a conservation status irrespectively of their number and location in the country. From the present survey it has become apparent, that the situation of mire ecosystems in Poland seems to be better than in several other Central European countries (esp. in terms of quantitative data). However, in several cases, there is an urgent need to apply advanced, mostly active protection methods, basing on the results of both extensive inventories, as well as of in-depth (hydro-)ecological investigations of the particular sites.

Key words: Mire habitats, Natura 2000, human impact, protection, Poland.

Introduction

The implementation of the Natura 2000 system in Poland has given a new impulse to and opened new opportunities for mires in our country. For the first time in history, these valuable and threatened ecosystems have achieved a certain conservation status irrespectively of their number and location in the country. Although only habitats situated within the Natura 2000 Habitat Sites are going to be surveyed and monitored regularly, the very inclusion of an ecosystem into the protected habitat list is focusing public interest to all mire sites. Such sites have to be distinguished in all regional and local studies, and their state has to be reported to appropriate nature protection authorities.

The current knowledge of mire resources in Poland is far from complete, due to the lacking of an up-to date inventory of mires and peatlands. However, there are ongoing efforts to fill the existing gaps in knowledge and, moreover, the requirements of the Natura 2000 program are strenghtening and directing these activities.

Mire resources in Poland

The former extent of mires in Poland can be evaluated by the distribution of peat deposits. Approximately, mires once covered 4.1 % of the country (1,278,000 ha). Their distrubution was uneven, the majority was found in the northern and eastern parts of the country (Fig. 1, Tab. 1). Although, peatlands once covered a considerable portion of some areas, at present the occurrence of living mires is much lesser, approximately 0.6% of the country (KOTOWSKI & PIÓRKOWSKI 2003). The loss of living mires, therefore, amounts up to 84 %.

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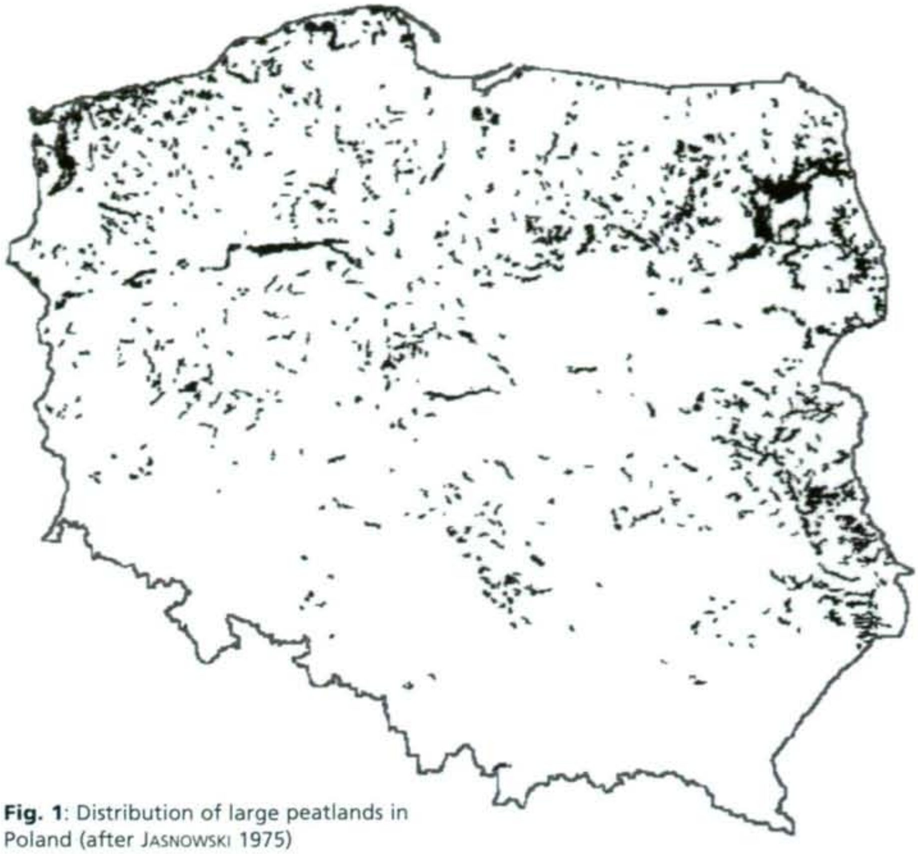

Fig. 1: Distribution of large peatlands in Poland (after JASNOWSKI 1975)

Mires as Natura 2000 habitats

Natura 2000 habitat sites is a network of protected areas established across European Union countries to enable survival of so-called protected habitats – a number of ecosystems declared by European Union as deserving special protection. The lists of protected habitats and species are published in form of two Annexes to the Habitat Directive – a piece of legislation accepted by all members of the European Union. In spite of universal definitions and descriptions (INTERPRETATION MANUAL... 1996), there is a certain liberty in the local understanding of the particular habitat in each of the member states. Among the 76 habitat types included on the Natura 2000 list for Poland (HERBICH 2004) there are 6 habitats of mires, namely: Active raised bogs (code *7110), Degraded raised bogs, still capable of regeneration (code 7120), Transition mires and quaging bogs (code 7140), Depressions on peat substrates (Rhynchosporion, code 7150), Lake-chalk mires with *Cladium mariscus* (L.) POHL and species of the Caricion davallianae alliance (code *7210) and Basiphilous mires (code 7230). The asterix within the habitat code denominates a habitat of priority importance for the Europaean Union.

Wet heathlands with *Erica tetralix* L. (code 4010) and Bog woodland (code *9110) are substantial components of mire complexes. Petrifying springs (Cratoneurion), code *7220) and Salt marshes (code 1330) are under Polish conditions only occasionally peat forming communities, but sometimes are forming important mozaics with other mire types. The following definitions and characteristics of the six major mire habitats are based on the chapters prepared by the Authors for the Polish version of the Manual for determination of habitat types (HERBICH 2004). Besides own data and experience, a mine of basic data, obtained from published and unpublished sources, were used for the preparation of this manual. The sources of the original data are listed in the reference section of each of the thematic chapters of this Polish written book (HERBICH op. cit.).

Tab. 1: Distribution of peat deposits in Poland (JASNOWSKI 1975)

Region	Percentage of peatlands in the area	Number of peatlands			Area of deposits		Average peat thickness
	%	n	%	total ha	total %	average ha	m
Northern zone of the Baltic coast-lakelands	7.7	36,498	74.2	826,773	64.9	22.7	1.56
Middland zone – flat lowlands	3.2	11,873	24.3	424.664	33.0	35.6	1.11
Southern highlands	0.4	774	1.5	26,757	2.1	34.5	1.02
Total	4.1	49,145	100.0	1,278,194	100.0	100.0	1.41

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Photo 1: Typical bog of the Sudety Mts. with mountain pine in the margin and open parts with pools and natural peat profile eroded by the river. Characteristic for Izerian bogs. (Photo A. RAJ)

Photo 2: Open part of Izerian bog with small, shallow, elongated pools, orientated perpendicularly to the slope. (Photo J. POTOCKI)

Definitions of mire habitats and their distribution in Poland

Raised bogs, fed almost exclusively by rainwater, are oligotrophic and very acid mires (Photos 1 – 4). Optimal conditions for their development and distribution are within the area of relatively cool and humid climate (nemoral zone). The water table in raised bogs is elevated above the ground water table of their surroundings and, therefore, every raised bog is an individual hydrological unit. Active raised bogs are vegetated mostly by peat mosses and very few species of flowering plants. All of them are highly adapted to extremely low nutrient conditions. Raised bogs are characterized by specific macro- and micro-relief. The phytocoenoses of hummock micro-habitats have the strongest peat-forming abilities. The process of peat accumulation and upward growth of a raised bog comes to an end when the water in-put and outflow become balanced.

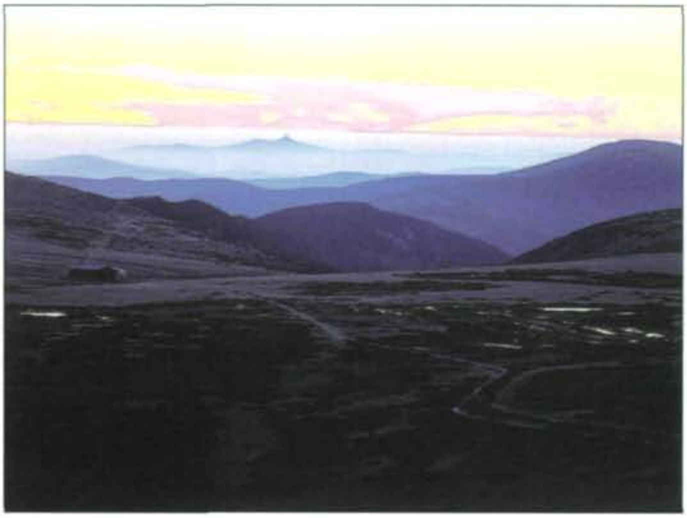

Photo 3: Bogs on the summit plateau of the Karkonosze Mts. – numerous pools reflect the light. (Photo A. RAJ)

Raised bogs in Poland are concentrated to the lowlands in the northern part of the country; the area of the Baltic glaciation (Fig. 2A). The true raised bogs (Baltic type), which are dependent on a maritime climate, reach their southern distribution limit in Poland not far from the coast (JASNOWSKI et al. 1968, JASNOWSKI 1975). The total number of such bogs in the country is circa 60. Mostly, their size ranges between 100 – 150 ha (op. cit.). They are located on watersheds, in ice marginal valleys and at the flanks of river valleys. On watersheds they have developed through paludification of the mineral soil or by terrestrialization of lakes (JASNOWSKI et al. 1968). The origin of raised bogs in ice marginal valleys and river valleys was preceded by fen development. The main peatforming species in the cupolas of these bogs was *Sphagnum fuscum* (SCHIMP.) KLINGGR. (JASNOWSKI 1962, PACOWSKI 1967, JASNOWSKI et al. 1968, JASNOWSKI 1975, HERBICHOWA 1998). Bogs located in depressions without runoff (kettle hole mires) are small (1-10 ha of area). They are especially numerous in outwash plains and young morainic landscapes (*inter allia* JASNOWSKA & JASNOWSKI 1981).

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Photo 4: Typical bog on the summit plateau of the Karkonosze Mts. without mountain pines in the margin. (Photo Archive of the Karkonosze National Park)

Photo 5: Peat-forming vegetation well regenerating in a peat excavation. (Photo J. HERBICH)

Photo 6: Spontaneous regeneration of the bog vegetation after moderate drainage of the raised bog and superficial peat excavation. (Photo J. HERBICH)

Photo 7: Remnants of a peat-forming vegetation on the drained cupola plateuax of a raised bog in the coastal region of Poland. (Photo J. HERBICH)

Photo 8: Spontaneous regeneration of the bog vegetation after moderate drainage of the raised bog and superficial peat excavation. (Photo J. HERBICH)

For climatological and geomorphological reasons raised bogs are almost lacking in the central (lowland) and upland parts of Poland. Raised bogs are also rather rare in the submountainous regions and in the mountains of southern Poland (JASNOWSKI 1975). Sudetes raised bogs represent a group of mires found in the mountains of Hercynic origin, situated in south-western Poland, at the border with the Czech Republic (Fig. 2B). At present the largest complexes of living raised bogs are found in the Karkonosze Mts. (the highest mountain range in the Sudety Mts.) and in the Izera Mts. Remnants of original larger bogs and small individual objects are found in the remaining Polish ranges of the Sudety Mts. i.e. in the Bystrzyckie and Stolowe Mts.

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Degraded raised bogs, which have the capability of regeneration, are bogs of which the natural hydrology has been disturbed, mainly due to man's activity, resulting into superficial dessication (Photos 5 – 11). The vegetation of these bogs consists of species characteristic of active raised bogs, but the relative abundance of individual species is different. The hydrology of such bogs can be repaired by proper hydrological measures, and re-establishing of the peat-forming vegetation can be expected within 30 years. Sites consisting largely of bare peat or sites covered by agricultural vegetation (crops or woodlands) are not included in this mire type.

Degraded bogs are distributed throughout the range of raised bogs in Poland, although they mainly occur in the northern part of the country (Fig. 2D) (JASNOWSKI et al. 1968).

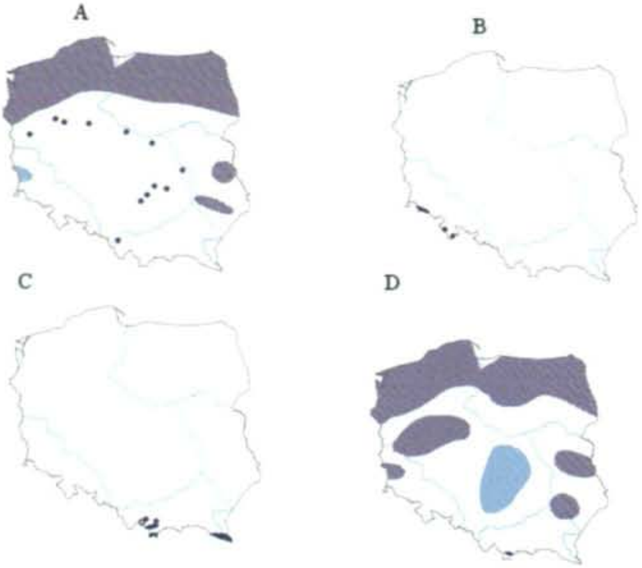

Fig. 2: Distribution of habitats of raised bogs in Poland. A – Lowland raised bogs *7110-1. B – Sudetes raised bogs *7110-2. C – Carpathian raised bogs *7110-3. D – Degraded raised bogs 7120-1.

Photo 9: Plateuax of the drained raised bog still capable of regeneration. (Janiewickie raised bog, Northern Poland). (Photo J. HERBICH)

Photo 10: Remnants of a peat-forming vegetation on the drained plateuax of a raised bog cupola in the coastal region of Poland. (Photo J. HERBICH)

Transition mires and quaging mires are developing close to the surface of oligo- to mesotrophic waters, supplied with both rain water and ground- or surface water. They are formed by differentiated peat-forming communities of floating vegetation carpets, consisting of sedges, peat and brown mosses (Photos 12 – 17).

Transition and quaging mires develop (1) in bays of and around oligo-, and mesotrophic lakes with stagnant or only slowly flowing water, (2) as free floating islets in such lakes, (3) in outflowless de-

Photo 11: A scarce regeneration of peat-forming vegetation in a ditch seasonaly filled by shallow water. (Photo J. HERBICH)

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Photo 12: Transition mire (floating mat) developing at a lake. (Kashubian Lake District, Northern Poland). (Photo J. HERBICH)

Photo 13: Transition mire (Kashubian Lake District, Northern Poland). (Photo J. HERBICH)

Photo 14: Transition mire (floating mat) developing at a lake. (Kashubian Lake District, northern Poland). (Photo J. HERBICH)

Photo 15: Transition mire "Sicienko" in the Drawa National Park (Photo J. HERBICH)

Photo 16: Transition mire (floating mat) developing at a dystrophic lake within the raised bog complex. (Kashubian Lake District, Northern Poland). (Photo J. HERBICH)

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Photo 17: *Rhynchospora fusca* (L.) W. T. Aiton, in Poland a very rare Atlantic species on transition and raised bogs. (Photo J. HERBICH)

Photo 18: Mass occurrence of *Rhynchospora alba* (L.) Vahl in peat depressions. (Janiewickie raised bog, Northern Poland). (Photo J. HERBICH)

pressions with water tables oscillating close to the surface, (4) in peaty depressions with a water lens enclosed in the peat body due to overgrowing of a lake (5) in submerged lagg zones of bogs, (6) around dystrophic pools on the expanses of raised bogs, (7) on wet soils of reclaimed lakes, and (8) on montaneous slopes, where they are supplied by seeping water. Secondary localities of the habitat are wet peat pits.

Typically, the vegetation of this mire habitat is built by emmersive plant communities, i.e. adjusting it's position to the actual water level. The root systems of plants are anchored in a very wet and soft surface layer which waves and swings under pressure, and may eventually break.

The habitat is frequent in northern Poland (Fig. 3A). The largest concentrations are found in in the outwash landscapes in which melt-out depressions are common (Bytów and Drawsko Lakelands, Tuchola Woods, Charzykowy Lowland – all in NW Poland, Augustów Woods – NE Poland). In morainic landscapes the transition and quaging mires are relatively rare. In the remaining part of the lowlands and in the uplands they are scarce, with the exception of the Leczna-Wlodawa Lakeland (SE Poland), where they are relatively common.

Mountain transition and quaging mires occur mainly in the Sudety Mts. (Karkonosze, Izera Mts., Stolowe Mts., Bystrzyckie Mts, Snieznik Massif, Orlickie Mts.). They are much rarer in the Tatra Mts., the submountain region of Podhale and the Bieszczady Mts.

Depressions on peat substrates (Rhynchosporion) are stabile and pioneer communities on wet, bare peat and sometimes sandy soils, with species such as *Rhynchospora alba* (L.) VACHL, *R. fusca* (L.) W.T. AITON, *Drosera rotundifolia* L., *D. intermedia* HAYNE, *Lycopodiella inundata* (L.) Holub, occupying open spaces in bogs, as well as in places naturally eroded by seeping or freezing water in bogs, wet heathlands and on shores of oligotrophic lakes on sandy or slightly peaty substrate. These communities are similar to and associated with those of shallow bog hollows and transition mires (Photo 18).

In the lowlands the habitat occurs in wet depressions on sand or shallow peat, at the margins of bogs overgrown by heathland vegetation. It is found also in temporarily very wet interdune slacks, in between stabilised dunes, on the shores of oligotrophic lakes and the borders of transition mires in outwash plains, in peat exploitation pits, and in bogs used by wild animals for mud baths and by cranes for nuptial dances. All known localities are small and cover from one to less than 20 m^2 (Photos 19 – 24).

In mountain areas bare peat occurs on sloping parts of mires which are susceptable

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Photo 19: Interdune depression in Bialogóra, Baltic sea coast. Initial mire vegetation: Eleocharetum multicaulis, Rhynchosporetum fuscae and Myricetum. (Photo J. HERBICH)

Photo 20: Initial mire in the interdune depression in Bialogóra, Baltic sea coast. (Photo J. HERBICH)

Photo 21: An interdune mire covered by advancing dune in the Slowinski National Park, Baltic sea coast, in 1991; mind the red mark! (Photo J. HERBICH)

Photo 22: An interdune mire covered by advancing dune in the Slowinski National Park, Baltic sea coast, in 1993; mind the red mark! (Photo J. HERBICH)

Photo 23: An interdune mire covered by advancing dune in the Slowinski National Park, Baltic sea coast, in 1997; mind the red mark! (Photo J. HERBICH)

Photo 24: An interdune mire covered by advancing dune in the Slowinski National Park, Baltic sea coast, in 2000; mind the red mark! (Photo J. HERBICH)

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to water erosion. As a result gullies and ponds are being formed, devoid of vegetation or vegetated only by few plant species. Such erosion complexes are now well documented for subalpine mires in the Karkonosze Mts.

Rhynchosporion communities have also been found in few locations in the coastal part of the Cashubian District in northern Poland, in the Sandomierz Basin (southeast Poland) and in the Karkonosze Mountains and fragmentarily in the Carpathian Mts. (Fig. 3B). The potential, very probable areas of distribution are associated with sandy areas (especially the outwash plains) of Pomerania, Augustów Woods (northeast Poland), Dolnoślaskie Woods (southwest Poland) and the Leczna-Wlodawa Lakeland.

"Lake-chalk mires" are shores of lakes, exposed gyttia deposits and fens on substrates very rich in calcium carbonate and supplied with water rich in calcium. The vegetation of this mires is dominated mainly by the tall rush *Cladium mariscus*, often in spatial complex with moss-sedge vegetation consisting of a considerable number of calciphilous species (JASNOWSKI 1962, JASNOWSKI et al. 1972) (Photos 25 – 26).

The distribution of lake-chalk mires in Poland is restricted to lowlands, where they have a limited, discontinuous distribution. (Fig. 4A). Most of lake-chalk mires are found in Pomerania (JASNOWSKI 1962, ŚWIEBODA 1968, HERBICH 1994), Masurian District, Suwalki Lakeland (JUTRZENKA-TRZEBIATOWSKI & SZAREJKO 2001), in Wielkopolska (KACZMAREK 1963, BRZEG & WOJTERSKA 1996), and the Lublin region (FIJALKOWSKI & CHOJNACKA-FIJALKOWSKA 1990, BUCZEK & BUCZEK 1993).

The majority of lake-chalk mires occurs in northern Poland, within the young-glacial areas of the last (Pomeranian) stage of the Baltic glaciation. The age of this land-

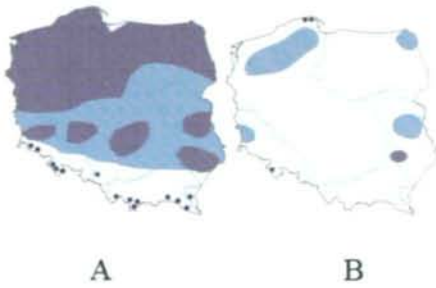

Fig. 3: Distribution of habitats of transition mires in Poland. A – Transition mires and quaging bogs 7140. B – Depressions on peat substrates (Rhynchosporion) 7150.

Photo 25: *Orchis militaris* and *Schoenus nigricans* in the lake-chalk mire at the shore of Miedwie Lake, NW Poland. (Photo L. WOLEJKO)

Photo 26: *Orchis militaris* in the lake-chalk mire at the shore of Miedwie Lake, NW Poland. (Photo L. WOLEJKO)

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Photo 27: Basiphilous, percolating mire in Suleczyno, Kashubian Lake District, Northern Poland. (Photo: J. HERBICH)

Photo 28: Percolating mire in the Ilanka river valley, Western Poland. Brown patches of *Juncus subnodulosus*. (Photo L. WOLEJKO)

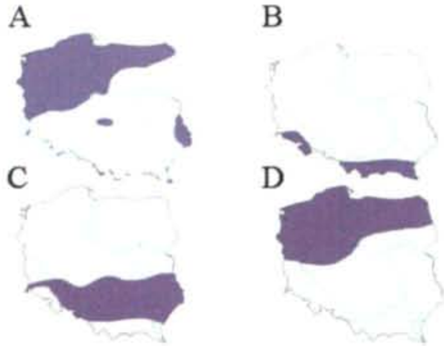

Fig. 4: Distribution of habitats of lake-chalk fens and basiphilous mires in Poland
A – Lake-chalk mires *7210
B- "Mountain flushes" 7230-1
C – Upland basiphilous mires of southern Poland 7230-2
D – Spring- and percolating mires of northern Poland 7230-3

scape does not exceed 20,000 years. It is characterised by large topographic variation, the abundance of lakes and active geomorphological processes. In this part of the country the mires were formed on lake chalk deposits. Mires in Leczna-Wlodawa Lakeland and in the environs of Chelm (southeast Poland) are situated in a much older landscape, which has been re-shaped for ca. 230,000 years. In the first-mentioned region peatlands have also developed on the lake-chalk deposits. In the Chelm region so-called "writing chalk" deposits, originating from the Upper Cretaceous, form an impermeable layer at the bottom of depressions, over which shallow peat layers (1-2 m) have developed.

Basiphilous mires are mesotrophic and meso-oligotrophic, slightly acidic to neutral and alkaline "flushes" (hanging mires), spring fens and percolating fens. They are fed by groundwater rich in bases, and are supporting various, geographically differentiated, peat-forming plant communities. The vegetation mostly consists of brown mosses and small sedges, many of them being basiphilous species. Some of these species occur outside their continuous geographical range, or close to their limits (Photos 27 – 33).

Basiphilous mires are distributed unevenly across the country (Fig. 4B-D). They are concentrated in the southern, mountainous part of Poland (with exception of the acidic rock regions of South-western

Photo 29: Percolating fen with sedge vegetation. Mlodno Nature Reserve, Western Poland. (Photo L. WOLEJKO)

Photo 30: Terrestrialising lake turning into percolating fen with sedge-moss vegetation. Mlodno Nature Reserve, Western Poland. Flowering *Menyanthes trifoliata*. (Photo L. WOLEJKO)

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Photo 31: Vegetation of calcareous fen with *Chara* sp. in the spring pools. (Photo L. WOLEJKO)

Photo 32: The Biebrza mire near Lipsk – the most extensive basiphilous percolating fen in Poland. (Photo L. WOLEJKO)

Photo 33: Travertin formation in the pools of a calcareous spring fen. (Photo L. WOLEJKO)

Poland), and in those upland regions where calcareous rocks occur. "Mountain flushes" are rather common in the Carpathian Mountains (especially in the lower mountain forest belt) but are less frequent in the Sudety Mts. (PAWLOWSKI et al. 1960, KORNAŚ & MEDWECKA-KORNAŚ 1967, MATUSZKIEWICZ & MATUSZKIEWICZ 1974, GRODZIŃKA 1975, HÁJEK 1999).

In lowlands, the occurrence of basiphilous (mostly percolating) fens can be associated with areas of younger glacial deposits (e.g. glacial till), rich in small limestone fragments or with larger deposits of loess soils. In northern Poland, basiphilous mires classified as spring mires and percolating mires, are relatively common, especially in young-glacial areas (WOLEJKO 2002). Outside that region, the basiphilous mires are especially well-represented in the Biebrza river ice-marginal valley (PALCZYŃSKI 1975).

Some geobotanical features of Polish mires

The vegetation of Polish mires shows a distinctive geobotanical differentiation, as does the whole plant cover of the country. In Poland several vegetational zones can be distinguished, determined by the main abiotic factors as climate, bedrock, hydrological conditions and soils: the zone of broadleaved woods, the contact zone of Western- and Eastern-Europe, and a broad lowland belt, ranging north from the Sudetes and Carpathians mountains to the area dominated by glacial-periglacial landscape (SZAFER 1972, MATUSZKIEWICZ 1980, 1999).

Against this background the main general features of the plant cover of Poland are:

1. a **transitional character** to the adjacent areas, which is best reflected in the flora. Due to lack of barriers from the East and the West, as well as the migration history of

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Photo 34: Marsh tea, *Ledum palustre* L., is more abundand on the Carpathian bogs than in the Sudety Mts. – the Bieszczady. (Photo B. CWIKOWSKA & C. CWIKOWSKI)

Photo 35: *Rubus chamaemorus* L. – a very rare species on the raised bogs in northern Poland and in The Sudety Mts. (Photo J. HERBICH)

species after the last (Vistulian) glaciation, among others boreal, oceanic and continental elements are represented in the present day Polish flora. Around 46 % of the flora consists of species that in Poland reach a part of their geographical distribution (northern, northeastern and eastern boundaries in particular). This structure is not only the result of the occurrence of mountain ranges in southern Poland, but also related to a distinctive continental gradient, typical for Europe (MATUSZKIEWICZ 1999).

2. **contrast between plant cover of the lowland and the rest of the country**. Lowlands (below 300 m a.s.l.) occupy almost 97 % of the area of Poland, uplands (between 300 m and 500 m a.s.l) – 2,9 % and mountains (above 500 m a.s.l.) – only 0.9 %. However, the altitudinal structure of the whole flora is quite different: over 25 % of species exclusively or mainly grow in the mountains and the remaining 75 % are typical for lowlands. Among plant associations the division is almost 21 % and 64 %, respectively, and only 10 % of the associations is committed to uplands and submontane regions (MATUSZKIEWICZ 1999).

3. **typical character, especially to the Centraleuropaean groups of geobotanical provinces**. In the flora and vegetation of the country European elements predominate, partly also Eurosyberian. It is reflected in the directional structure: almost 54 % of the species and 58 % of the plant associations have no boundary within the Polish territory. Also the portion of endemic plant species and associations is very low (1 % and 12 %, respectively). The last figure includes almost only montane associations (MATUSZKIEWICZ 1999).

In general, Polish mire flora is characterized by a relatively high number of species distributed mainly in the boreal or arctic zone, but representing various geographical elements (JASNOWSKI 1975). Some of them reach the limit of their continuous distribution area within Poland or even grow on isolated, remote sites (for example *Carex chordorrhiza* L.f., *C. pauciflora* LIGHTF., *Chamaedaphne calyculata* (L.) MOENCH, *Baeothryon alpinum* (L.) T.V. EGOROWA, *Rubus chamaemorus* L., *Pedicularis sceptrum-carolinum* L.) (CZUBIŃSKI 1950, JASNOWSKI et al. 1968, JASNOWSKI 1975). Species growing not far from the western boundary of their distribution area, such as *Ledum palustre* L. (Photo 34), *Carex lasiocarpa* EHRH., *C. diandra* SCHRANK and *Sphagnum fuscum*, also belong to this group.

The north-eastern part of Poland, including the Biebrza Valley fens, is especially rich in these species (PALCZYŃSKI 1975). Moreover, some of the species (for instance *Carex pauciflora*, *Rubus chamaemorus*) also occur in montane altitudes. In the eastern part of the country sites are found of several species prefering more continental climate, such as *Salix lapponum* L., *S. myrtilloides* L.,

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Photo 36: *Erica tetralix* L. – an Atlantic species, in Poland at the eastern border of the geographical distribution, relatively common on the moderately drained raised bogs in the coastal region. (Photo J. HERBICH)

Photo 37: *Erica tetralix* L. – an Atlantic species, in Poland at the eastern border of the geographical distribution, relatively common on the moderately drained raised bogs in the coastal region. (Photo J. HERBICH)

Photo 38: *Rhynchospora fusca* (L.) W. T. AITON. – in Poland a very rare Atlantic species on transition and raised bogs. (Photo J. HERBICH)

Photo 39: *Myrica gale* L. – a mire species in Poland limited to the very narrow coastal belt. (Photo J. HERBICH)

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and *Betula humilis* SCHRANK. Arctic species are extremely rare in Polish mires. They are found exclusively (*Pedicularis sudetica* WILLD.) or mainly (*Betula nana* L., *Sphagnum lindbergii* SCHIMP.) in the Sudety Mts.; exceptionally they are limited to the lowlands (*Carex microglochin* WAHLENB). Most of the listed species, and also mosses as *Scorpidium scorpioides* (HEDW.) LIMPR., *Meesia triquetra* (L. ex JOLYCL.) ÅNGSTR., *Cinclidium stygium* SW in SCHRAD., *Helodium blandowii* (F. WEBER & D. MOHR) WARNST., *Paludella squarrosa* (HEDW.) BRID. and *Tomenthypnum nitens* (HEDW.) LOESKE, are considered to be glacial relics.

Several relic species, typical for boreal and subarctic Europe, are found in plant communities of bogs of the Izera Mts. (IM) and the Karkonosze (K). These are, for example *Betula nana* L. (IM – two of three Polish localities are found in Sudetes), *Rubus chamaemorus* (K – the most southern findspot, Photo 35), *Pedicularis sudetica* (K, at the margins of some mires) and *Sphagnum lindbergii* (K). Besides there are several species, representing the boreal and boreo-alpine type of distribution: *Empetrum hermaphroditum* (IM, K), *Baeothryon caespitosum* subsp. *caespitosum* (IM, K), *Oxycoccus microcarpus* (IM, K), *Sphagnum fuscum* (IM, K), *Sphagnum jenseni* (IM, K), *Sphagnum majus* (K). Species representing the oceanic and suboceanic distribution region include *Pedicularis sylvatica* (IM), *Sphagnum papillosum* (IM, K), and *Gymnocolea inflata* (IM, K).

A specific feature of mires in the Sudetes is the encroachment of *Pinus mugo* on the margins or drier parts of mires. In the Izera Mts. and the Bystrzyckie Mts. this species grows outside of it's natural zone. Surprisingly, in the Snieznik Massif (also in its mires!) mountain pine is missing completely.

Atlantic or subatlantic species are characteristic for the north-western part of Poland (Pomerania), especially in the coastal zone. Examples are *Erica tetralix* L. (Photos 36, 37), *Rhynchospora fusca* (Photo 38), *Baeotryon cespitosum* subsp. *germanicum* (PALLA) Á. LÖVE & D. LÖVE, *Pedicularis sylvatica* L., *Drosera intermedia*, *Utricularia ochroleuca* R. W. HARTM., *Schoenus nigricans* L., *Sphagnum imbricatum* HORNSCH., *S. molle* SULL. and *S. papillosum* LINDB. Some of them (for instance *Erica tetralix*) reach the eastern limit of their distribution area here. *Myrica gale* L. (Photo 39) occurs only in a very narrow belt of the coastal zone. Species demanding a relatively mild climate occur also is the south-western part of Poland (Lower Silesia Forest).

Characteristics and current status of mire habitats

Active raised bogs

Active raised bogs are ombrotrophic (ombrogenous) mires and include true raised bogs and ombrotrophic kettle-hole mires (Photos 40 – 42). In both cases the shape of the peat deposit is more or less domed. The water table on the plateau of the living (active) raised bog is close to the surface, especially in hollows, whereas slopes of the bog are noticeably drier. A lagg, surrounding the cupola, is usually very wet, mesotrophic and moderately acid. The vegetation on the plateau is usually treeless and consists of hummock-hollow complexes (Photos 43, 44). The slopes of the dome might be overgrown by pine or birch bog forest (on lowlands) or (in the mountains) by dwarf pine, birch or spruce.

Polish bogs have been divided into three groups: Lowland raised bogs, Sudetes raised bogs and Carpathian raised bogs.

Lowland raised bogs

The shape, size and vegetation of the lowland raised bogs are closely related to the climatic gradient of Northern Poland and to local geomorphological conditions. Raised bogs of the Baltic type and of the continental type are especially dependent on such climatological factors as: annual rainfall, its distribution over the year and annual and monthly temperatures.

The Baltic type bogs are situated mainly in the north-western part of Poland, which is under the distinct influence of a maritime climate. As a type of ecosystem they are one of the most important geobotanical features of this region. Baltic raised bogs are usually larger than 100 ha and the height of their dome can reach 1.5 m. A main peat-forming species in the past was *Sphagnum fuscum*,

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Photo 40: A kettle hole mire. (Kashubian Lake District, Northern Poland). (Photo J. Herbich)

Photo 41: A kettle hole mire (Kashubian Lake District, Northern Poland). (Photo J. Herbich)

Photo 42: A kettle hole mire in Drawa National Park. (Photo J. Herbich)

Photo 43: Hollow and hummock structure on an active kettle hole mire (Kashubian Lake District, northern Poland). (Photo J. Herbich)

more rarely *Sphagnum magellanicum* Brid. The present day vegetation of the active Baltic raised bogs consists of hummock and hollow associations on the best preserved parts of plateaus. However, not a single bog of this type has been retained in pristine state (Photo 45). The hummocks mainly consist of *Eriophorum vaginatum* L., *Oxycoccus palustris* Pers., *Calluna vulgaris* (L.) Hull, *Drosera rotundifolia*, *Sphagnum magellanicum*, *S. rubellum* Wilson, *S. capillifolium* (Ehrh.) Hedw., *Polytrichum strictum* Menzies ex Brid., and very seldom by *Sphagnum fuscum*. On some bogs *Erica tetralix* is a common species and also such Atlantic and subatlantic species as *Baeotryon cespitosum* subsp. *cespitosum* (L.) T.V. Egorowa, *Sphagnum molle*, *Cladonia portentosa* (= *C. impexa*) are frequent. *Erica tetralix* communities are clas-

Photo 44: Hollow and hummock structure on an active kettle hole mire (Kashubian Lake District, northern Poland). (Photo J. Herbich)

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Photo 45: *Molinia caerulea* L. invasion along a deep canal after around 200 years of its functioning – an example of irreversible changes in habitat and vegetation of the Baltic type raised bog (Janiewickie raised bog, northern Poland). (Photo J. Herbich)

Photo 46: Abundant occurence of *Erica tetralix* on a drained raised bog in the coastal region of Poland. (Photo J. Herbich)

sified as Erico-Sphagnetum magellanici, however the phytosociological nomenclature of the raised bog vegetation in Poland needs general analysis and revision (Photo 46). The hollow vegetation has no regional features and is represented by Caricetum limosae and Rhynchosporetum albae associations. The slopes of the Baltic raised bogs are overgrown mostly by pine bog forest Vaccinio uliginosi-Pinetum, in the lower parts it can be replaced by birch bog forest Vaccinio uliginosi-Betuletum pubescentis.

The continental type of raised bogs in Poland occurs in the north-eastern part of the country where climate is more severe and dry in comparison to the north-western region. These bogs are located on watershed positions. Their surface is relatively flat and usually lack a well developed lagg zone. The most open parts of continental bogs are occupied by hummocks on which *Ledum palustre* grows in abundance. Scarce and low *Pinus sylvestris* is also characteristic.

The Ledo-Sphagnetum magellanici association has been found relatively often on continental bogs but its real distribution in Poland is not well known. The driest fragments of the continental bogs are covered by pine bog forest with abundant *Ledum palustre*. It is not quite clear whether bogs of this type actually can be considered as active bogs or rather should be classified as bogs in the terminal stage of their growth.

Small active raised bogs (oligotrophic kettle hole mires) are treeless and covered mostly by peatmoss associations. Such bogs have no regional features within Poland. They are numerous in the lakeland zone of the northern part of the country. The Bytowskie Lakeland, situated in eastern Pomerania, in the area of considerably undulating outwash plains, is especially rich in them. The hummocks on such bogs are usually low or moderately elevated, the hollows are very wet – the water table is very close to the surface and stable throughout the year. Typical hummock associations are Sphagnetum magellanici and Sphagnetum papillosi. In hollows occur Caricetum limosae and Rhynchosporetum albae associations in typical forms or other subunits. A lagg zone is prominent and overgrown by oligo-minerotrophic vegetation, for instance Sphagno-Cariceum rostratae or Caricetum lasiocarpae phytocoenoses.

Carpathian raised bogs

The geology and relief of the Polish Carpathian Mountains are not suitable for development of larger mire complexes. Such objects occur only in bigger valleys, like Orawa–Nowy Targ Basin (Photo 47) or San valley.

Carpathian bogs have developed mainly at: areas with postglacial relief (small overgrowing water basins within morain landscape – the Tatras), meadow terraces (Orawa–Nowy Targ Basin, the Bieszczady),

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watershed areas (Orawa–Nowy Targ Basin), and lower, less steep slope parts (Babia Góra massif, Polica range). In particular physiographic units, the origin and water supply of bogs differ significantly. Some bogs have developed through terrestialization of smaller lakes (the Tatras), some other through paludification, i.e. swamping of dry land (the remaining rigdes, partly the Tatras). It means that the Carpathian bogs are a heterogenous group.

Most of Carpathian bogs may be found within the foothill zone (300 – 550 m a.s.l.) or especially mountain forest zones (550 – 1.350 m a.s.l., in the Tatras to 1550 m a.s.l.). In the Tatras they occur even higher, in the subalpine region (1600 – 2350 m a.s.l.). In the Polish part of these mountains only some peat kettles have developed: smaller patches of bog vegetation on lakes' water surface, or on thin peat layers, sometimes partly covered by solifluction forms. In the Slovak part bogs of these types may be both bigger and much higher situated.

The Carpathian bogs are dominated by vegetation of hummock complex (class *Oxycocco–Sphagnetea*), while the vegetation of the hollow complex is of marginal importance. This is characteristic for all Polish Carpathian ranges. Depending on water soaking, in double-layer hummock complex communities, either peat-moss species or herbs and dwarf shrubs are dominating. On the driest parts, with the biggest water level fluctuations (> 30 cm), peat-moss communities develop (formed by *Sphagnum capillifolium*, **S. compactum* LAM. & DC., **S. magellanicum*, **S. papillosum*, **S. rubellum*, *S. fuscum*, accompanied by *Polytrichum commune* HEDW. and **Eriophorum vaginatum*, **Drosera rotundifolia*, **Carex pauciflora*). Large areas are covered by dwarf shrubs: *Vaccinium* sp., *Calluna vulgaris*, *Oxycoccus palustris*, **Andromeda polifolia* L., while **Empetrum nigrum* L. s. str. and *Ledum palustre* are more rare. On many drier areas tree species are encroaching: *Pinus mugo* TURRA. (the Tatras, Orawa–Nowy Targ Basin), *Pinus x rhaetica* BRÜGGER (Orawa–Nowy Targ Basin), *Picea abies* (L.) H. KARST. (the Babia Góra massif, the Polica range, the Bieszczady). *Pinus sylvestris* L. while other tree species play a minor role. Only on the Tatra bogs of lacustrine origin the occurrence of communities requiring inundation (Caricetum rostratae, Caricetum limosae) is more prominent. The most important species creating these communities are **Sphagnum majus* (RUSS.) C. JENS., **S. fallax* (KLINGGR.) KLINGGR., *Warnstorfia* sp. (*Drepanocladus* sp.), **Scheuchzeria palustris* L., *Rhynchospora alba*, **Juncus filiformis* L., **Carex limosa* L., **C. rostrata* STOKES, *C. canescens* L., and **Eriophorum angustifolium* HONCK.

(* – species characteristic in phytosociological meaning; in bold – dominant species)

Photo 47: Open bog parts in the Orawa-Nowy Targ Basin are a habitat of mountain pine, *Pinus mugo* TURRA, and their hybrids with Scots pine, *Pinus sylverstris* L., known as *Pinus x rhaetica* BRÜGGER. (Photo J. POTOCKA)

Photo 48: Only few bogs of the Bieszczady have wide open parts like Tarnawa bog. (Photo B. CWIKOWSKA & C. CWIKOWSKI)

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Photo 49: Depressions as a result of subpeat erosion in a subalpine bog of the Karkonosze Mts. (Photo J. POTOCKA)

Photo 50: Loaf-like mountain pine shrubs on a sublapine bog grow on drier, elevated surface alternating with submerged hollows. (Photo A. RAJ)

In case of the Carpathian bogs, climatic factors play a definitely minor role in creating diversity, to the contrary of the Sudety bogs. It is easy to explain, because only the Tatra bogs have developed within different climate and vegetation belts (OBIDOWICZ 1996). Diversity in vegetation, structure of peat deposit and cupola profile are directly correlated to the origin of bog itself and of the waters supplying it. The most elevated, loaf-shaped cupolas are characteristic for the Bieszczady bogs (Photo 48). Those of the Tatra bogs which have originated in the process of overgrowing of water basins, have an almost flat surface. The most regular cupolas have been characteristic for the bogs of Orawa–Nowy Targ Basin. Unfortunately, today they are severely disformed due to peat exploitation.

The vegetation of Carpathian bogs is relatively uniform and poorer in subarctic and subarctic-alpine species characteristic for the Sudeten bogs. One of the few characteristic elements here is the hybrid of Scots pine and mountain pine, *Pinus* x *rhaetica*. It is a Central European species with the centre of occurrence in Poland just in the Orawa–Nowy Targ Basin (while in the Sudetes known practically only from two localities). Its ecological role resembles of that played by *Pinus rotundata* LINK; the possible relationship between these two species are constantly under discussion.

The curiosity of the Tatra peatbogs communities on the background of the other mountain bogs in Poland is the occurrence of *Baeothryon alpinum*, (*Trichophorum alpinum* (L.) PERS.), a species related to the spring communities. On the Slovak side an association Sphagneto–Trichophoretum alpini has been described, in which *Sphagnum compactum* occurs.

Vegetation dynamics

Changes in vegetation of Carpathian peatbogs are consistent with the general developmental trends for European bogs. They are influenced by changes in climate and in water status, including those in chemical composition of water saturating the peat deposit.

The vegetation overgrowing water basins in the Tatras resembles the vegetation of overgrowing dystrophic lakes: directly by the open water surface it creates a quag formed by peat-mosses, brown mosses tolerating inundation, e.g. *Warnstorfia* sp., and sedges – among others *Carex limosa* and *Carex rostrata*. A zone closer to the margin, with thicker peat layer, is colonized by typical bog vegetation. The next zone becomes in turn overgrown by mountain pine and Norway spruce. Of course in natural conditions this process takes hundreds or thousands of years.

Nowadays the typical bog vegetation is in regress, and it happens unfortunately in

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places where bogs have been most significant as a landscape component: Orawa-Nowy Targ Basin (OBIDOWICZ 1978, 1990) and the Bieszczady. It is difficult to say in which degree a fact of common occurrence of trees (Norway spruce and birches) on the Bieszczady bogs is caused by human activity, and in which degree a result of natural processes. This may be a natural state in bogs that reached the final phase of evolution (see MAREK & PALCZYŃSKI 1962, RALSKA-JASIEWICZOWA 1980).

In fact the situation of bogs in the Orawa–Nowy Targ Basin may be considered as critical. Their economical exploitation began already few hundred years ago by cutting down trees at marginal parts and grazing within the open parts. In XIXth century local inhabitants began peat exploitation on a larger scale, mainly for fuel. The scale of this activity may be indicated by a diminution of the Przymiarki bog: in the beginning of 1950s it was ca. 2 km long and 750 m wide, while in 1976 – 434 m long and 228 m wide. It is known today, that the total area of bogs in the Orawa–Nowy Targ Basin has shrinked from 4.282 ha to 2.836 ha (34%), and the area of their cupolas decreased from 1977 ha to 1.312 ha (also 34 %; LAJCZAK 2001a). Three of these bogs were completely excavated. Unfortunately, bogs in this area have been unprotected, except a single object where a nature reserve has been created ("Bór na Czerwonem"). Moreover, after World War II some bogs have been carelessly destroyed through adaptation to an industrial exploitation. This projects were abandoned afterwards. The ideas of industrial exploitation of bogs are again actual in this region. One of the bogs have been exploited since 1998 (10 year concession).

In spite of those distortions mentioned above, bogs of the Orawa–Nowy Targ Basin are still definitely worth protection (LAJCZAK 2001b). This is still more important, because the Slovak part of this peat bog complex does not exist any more – it has been inundated by waters of the Oravsky Reservoir. The only chance to rescue the rests of this complex is purchasing of the private grounds. Some education action among the local inhabitants is necessary, because they are reluctant to end the exploitation for self-needs, not to tell about selling the grounds.

Other Carpathian bogs remain practically unchanged. Those situated within the boundaries of national parks (the Babia Góra, the Tatras, partly the Bieszczady) are not threatened by any direct human activity.

Sudeten raised bogs

The Sudetes are old mountains of the Hercynic type for which extensive peatland complexes are a characteristic feature. At present the largest complexes of living rised bogs are found in the Karkonosze and in the Izera Mts. In the remaining Polish ranges of

Photo 51: The subalpine bogs are contrasting with the rocks of the Sniezka, the highest summit of the Karkonosze Mts. (Photo A. RAJ)

Photo 52: The mysterious beauty of subalpine mires caused fear and legends. (Photo A. RAJ)

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Photo 53: The frosty and windy summit plateaus of the Karkonosze Mts. are named „the Arctic island in the centre of Europe". (Photo A. RAJ)

Sudetes i.e. in the Bystrzyckie and Stolowe Mts., only the remnants of original larger complexes or some smaller individual objects are found. State border between Poland and Czech Republic often goes across mire complexes or larger mires. The following text concerns only the Polish part of the Sudetes, and it is based on author's own researches (some of them were published), and partly on regional works of other authors.

Photo 54: Pool with bottle sedge, *Carex rostrata* L. (Photo M. MAKOWSKI)

Nowadays, all mires in the large basins are gone, due to settlement of this more accessible terrain, which started already in the Middle Ages. All bogs in the Sudetes are situated within the forest complexes of the forest belts (500 – 1.250 m a.s.l.), especially in the mountain spruce forest, and in the subalpine subregion (1.250 – 1.450 m a.s.l.). In some mountain ranges (especially in the Izera Mts.) the lower border of the mountain spruce forest is lowerd by ca. 200 m, and the majority of bogs are situated at 800-850 m a.s.l.

Among bogs of the Sudetes the following mire types can be distinguished according to their topographic position:

- ridge mires (saddle bogs) in the Izera Mts., Karkonosze (Photos 49 – 53), Snieznik Massif, in some locations typical mountain-top mires;
- slope mires;
- valley mires on river terraces (mainly in the Izera Mts.);
- watershed mires (Bystrzyckie Mts.).

Bogs of the Sudetes have rather no conspicuous cupolas. They are often elongated because of their position on slopes. Only the subalpine bogs in the Karkonosze reflect in their topography the relief of the underlying terrain (cf. atlantic plateau bogs).

Not all of the described mires are strictly ombrotrophic. Groundwater had an important role in the origin and development of the majority of them. Also today groundwater supplements the water budget of bogs, even of those situated on mountain plateaus and saddles. Within mountain ranges built of granitoid and gneiss rocks (the Karkonosze and Izera Mts.) such waters are acidic and of a low mineral content.

The hummock-hollow structure, typical for bogs in other parts of Poland, is only slightly pronounced in bogs of the Sudetes. Instead, the characteristic feature for open parts of these bog are bog pools. The largest pools, a couple of metres deep and covering some tens of square metres, are situated in the thickest parts of bogs. In the mountain bogs, places with the thickest peat do not necessarily occur in the geometrical centre of the bog. Larger pools, regular in shape, are usually surrounded by several smaller

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and shallower, elongated pools. They are usually oriented perpendicularly to the slope. Pools may slowly overgrow with vegetation typical for wet depressions (Photo 54) with domination of *Carex limosa*, *C. rostrata* or *Eriophorum angustifolium* and with accompanying mosses: **Sphagnum balticum* (RUSS.) C. JENS., **S. majus*, *S. jensenii* H. LINDB., **S. fallax*, **S. lindbergii*, **Warnstorfia fluitans* (HEDW.) LOESKE (= *Drepanocladus fluitans* (HEDW.) WARNST.) (POTOCKA 1997). In some other pools vegetation is completely missing. The succession leading to the disappearance of pools may last hundreds to thousands years. In shallow depressions on exposed, bare peat the following species occur: **Rhynchospora alba* (missing in the Karkonosze and the Izera Mts.), **Scheuchzeria palustris*, *Juncus filiformis*, **Drosera anglica* HUDS., **D. intermedia* (only in the Izera Mts.), *D.* x *obovata* MERT. & W.D.J. KOCH, **D. rotundifolia*, **Carex nigra* REICHARD, **Lycopodiella inundata* (only in the Izera Mts.).

Another feature of the open bogs in the Karkonosze and, to lesser extent, the Izera Mts., are erosion gullies, sink holes and tunnels in peat.

In the vegetation of open parts of bogs peat mosses dominate (*Sphagnum capillifolium*, **S. compactum*, *S. cuspidatum* EHRH. ex HOFFM., **S. fuscum*, **S. magellanicum* **S. papillosum*, **S. rubellum*, **S. tenellum* (BRID.) PERS. ex BRID.), brown mosses **Polytrichum strictum*, *P. commune*, and the liverwort Gymnocolea *inflata* (HUDS.) DUM. The most typical species of the herb layer are: **Empetrum nigrum*, *E. hermaphroditum* HAGERUP, **Vaccinium uliginosum* L., *V. myrtillus* L., *V. vitis-idaea* L., **Andromeda polifolia*, **Drosera rotundifolia*, **Carex pauciflora*, **Baeothryon caespitosum* A. DIETR. ssp. *caespitosum* (*Trichophorum caespitosum* ssp. *austriacum*), **Eriophorum vaginatum*, *Calluna vulgaris*, **Oxycoccus palustris*, and *O. microcarpus* TURCZ. ex RUPR. (POTOCKA 1997, 1999a). (* – species characteristic in phytosociological meaning; in bold – dominant species)

Trees occur sporadically, usually as dwarfed, singular specimen of reduced vitality. In bogs with mountain pine, growing in the central part of the mires, this species rarely covers more than 30 % of the area and reaches the maximum height of 0.5 m. Shrubs of mountain pine growing in open parts of bogs attain a characteristic loaf-like shape, which is attributed to the frost and wind action (especially in the Karkonosze and Izera Mts.). At marginal parts of bogs this species grows more densely, has a different shape and average height of ca. 2m.

Among the Sudeten bogs, those of Western Sudetes (the Izera Mts. and Karkonosze) form a clearly distinct group. Bogs in other parts of the Sudetes do not play any important role in the landscape, but their presence is still more prominent than in the Carpathian Mountains.

Only in the Karkonosze occur plant communities of the alliance Oxycocco-Empetrion and wet depression communities of *Carex limosa* with *Sphagnum lindbergii* and *Sphagnum majus*, and, at the margins of wet depressions also Calliergo sarmentosi-Eriophoretum angustifolii (HADAŠ & VÁŇA 1967). Also in that region, peatland surface relief with big and small pools, typical for Hercynic bogs, is best developed.

These mountains are the only Hercynic massif with such a large area of above tree line bogs, so-called subalpine-subarctic bogs, and natural conditions of the summit plateau that are typical both for far North and high mountains (SOUKUPOVÁ et al. 1995). Karkonosze is called "an Arctic island in the middle of Europe". According to Czech authors (JENÍK & SOUKUPOVÁ 1992), some phenomena of subalpine Karkonosze mires resemble these of the atlantic plateau bogs, the aapa mires (string mires – mixed-type) of the northern regions and symmetrical and asymmetrical bogs. These mires show also several physiognomic similarities to mountain mires of Scandinavia. At the surface of subalpine mires of the Karkonosze the active cryogenic landforms are present (KOCIÁNOVÁ & STURSOVÁ 2002; probably closer of character to pounikko than palsa peat mounds; pounikko has only seasonally frozen core contrary to the permanently frozen core of palsa).

In subalpine bogs of the Karkonosze a typical lagg zone and the regular (concentric or eccentric) pattern of vegetation is usual-

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ly missing. Instead, there are drier elevations with dwarf pine, regularly interspaced with wet depressions in a manner similar to string-and-pool surface pattern of aapa mires (mixed-type).

The similarity to atlantic plateau bogs is expressed by the fact that the surface of bogs in the Karkonosze reflects the underlying terrain, and that erosion complexes have developed in the mires. The latter phenomena may also prove, that bogs of Karkonosze have attained the final stage of development.

Mires in Izera Mts. belong to the very few places in Poland where a lateral erosion of bogs, situated on river terraces, occurs. Moreover: this is a common phenomenon within Izerian valley bogs (POTOCKA 2000). As a result, natural cross-sections of peat deposits can be observed, similar to those found in the Sumava (Bohemian Forest) or in the Alps.

Vegetation dynamics

The bogs in the Sudetes have originated through paludification of mineral soils (TOLPA 1949). The initial stages of development were dominated by transitional mire communities with *Carex rostrata* and *Eriophorum angustifolium*. In some cases succession started with open water communities, occupying shallow depressions (the Bystrzyckie Mts.) or with the communities of *Carex paniculata* L. and *Alnus* sp. (the Stolowe Mts.). No mires of lacustrine origin are known to exist at present, however, occurrence of two such mires has been documented recently on Polish and Czech side from the beginning of Holocene (CHMAL & TRACZYK 1999, JANKOVSKÁ 2004). They developed between moraine ridges in the postglacial valleys of the Karkonosze.

In the course of succession the bog communities tend towards the dwarf shrub communities with *Calluna vulgaris* and *Vaccinium* spp. and eventually to *Pinus mugo* and/or *P. x rhaetica* bog woods or to stands of mountain spruce bog wood. Air pollution, fertilizing and liming of forests (especially by using airplanes) may induce the excessive growth of algae in dystrophic pools. Trampling, forest works, the presence of large game populations, etc. increase the danger of surface erosion in mires.

The most commonly observed human induced changes result from drainage. At first it leads to the withdrawal of vegetation of small pools and later to the disappearance of peatmosses. In the lagg zone the expansion of communities dominated by *Molinia caerulea* (L.) MOENCH and *Deschampsia caespitosa* (L.) P. BEAUV. is observed. In this zone also some other communities of the Molinio-Arrhenathereta class may develop. In the Karkonosze the marginal parts of mires are often occupied by poor grasslands of Carici rigidae-Nardetum. This community grows on a thin layer of mineralised peat in the zone transitional to mineral ground, at least in part developed due to human activity.

Undoubtedly bogs of the Sudetes are in the last developmental stages nowadays. This is shown by vegetation of the standstill complex, which is present at each bog (dwarf pine scrub and/ or mountain mire spruce forest). Natural factors are responsible for it, as age of bogs, peat thickness, severe climate (especially in the Karkonosze) or erosive river activity (the Izera Mts.). Human activity only intensifies and accelerates vegetation changes but it is not the general reason of stadstill complex development (POTOCKA 1999b).

Degraded raised bogs still capable of natural and stimulated regeneration

The vegetational indicators of hydrological disturbances in raised bogs can be: (1) diminishing of area occupied by vegetation of a hummock-hollow complex or other treeless phytocoenoses dominated by peatmoss species, (2) total disappearance of the peatmoss vegetation and occurrence of the dwarf-shrub communities (*Calluna vulgaris*, *Ledum palustre*, in the coastal region also *Erica tetralix*), also communities abundant in *Eriophorum vaginatum* or *Molinia caerulea*, (3) permanent occurrence of scarce and low individuals of *Pinus sylvestris*, and (4) typically developed or moderately changed pine bog phytocoenoses. Hydrologically disturbed raised bogs maintain the oligotrophy and high acidity of peat soil. In some cases the trophic status can rise as the result of enrichment of the soil in nitrogen and phosphorus originating from the mineralized peat. The water table in these bogs has been lowered around 20-50 cm in comparison to

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Tab. 2a: Syntaxonomic position of vegetation of Polish mire habitats – lowland raised bogs, Sudetes raised bogs and Carpathian raised bogs

Habitat type	Subtype & Natura 2000 code	Vegetation unit
Active raised bogs	Lowland raised bogs 7110-1	Class Oxycocco-Sphagnetea Braun-Blanquet et R. Tüxen 1943 Order Erico-Sphagnetalia (Sphagno-Ericetalia) (Braun–Blanquet 1948) em. Moore (1964) 1968 All. Oxycocco-Ericion (Nordhagen 1936) Tüxen 1937 Ass. Erico-Sphagnetum magellanici (Schwickerath 1933) em. Moore 1968 Order Sphagnetalia magellanici (Pawlowski 1928) Moore (1964) 1968 All. Sphagnion magellanici Kästner et Flössner 1933 em. Dierssen 1975 Ass. Sphagnetum magellanici (Malcuit 1929) Kästner et Flössner 1933; Eriophoro vaginati-Sphagnetum recurvi Hueck 1925 (=Eriophorum vaginatum-Sphagnum fallax comm.); Ledo-Sphagnetum magellanici Soukopp 1959 em. Neuhäusl 1969
Active raised bogs	Sudetes raised bogs 7110-2	**Hummock vegetation** All. Oxycocco-Ericion (Nordhagen 1936) Tüxen 1937 Ass. Scirpo austriaci-Sphagnetum papillosi (Schwick.1933) Moore 1968 (fragment) All. Sphagnion magellanici Kästner et Flössner 1933 em. Dierssen 1975 Ass. Sphagnetum magellanici (Malcuit 1929) Kästner et Flössner 1933; Eriophoro vaginati-Sphagnetum recurvi Hueck 1925; Eriophoro-Trichophoretum caespitosi (Zlatník 1928, Rudolph et al. 1928) Rübel 1933 em. Dierssen 1975 All. Oxycocco (microcarpi)-Empetrion hermaphroditi (Nordhagen 1936) R.Tx. 1937 Ass. Empetro-Trichophoretum austriaci Jeník 1961 em. Matuszkiewicz 1974, (?) Empetro hermaphroditi-Sphagnetum fusci Du Rietz 1921 (1926) em. Dierssen 1978; Sphagno robusti-Empetretum hermaphroditi Hadac et Vána 1967 em. Neuhäusl 1984; Chamaemoro-Empetretum hermaphroditi Soukupová et al. 1991
		Hollow vegetation All. Rhynchosporion albae Koch 1926 Ass. Caricetum limosae Br.-Bl. 1921 (and: Sphagno lindbergii-Caricetum limosae (Osvald 1925) Nordhagen 1927; Sphagno duseni-Caricetum limosae Rudolph et al. 1928; Scheuchzerio-Sphagnetum cuspidati Osvald 1923); Rhynchosporetum albae Koch 1926; Eriophoro angustifolii-Sphagnetum recurvi Jasnowski et al. 1968 (and: Calliergo sarmentosi-Eriophoretum angustifolii Nordhagen 1927) All. Caricion lasiocarpae Vanden Bergh. ap. Lebrun et al. 1949 Ass. Caricetum lasiocarpae Osvald 1923, em. Dierssen 1982 (incl. Carici filiformis-Sphagnetum apiculati Waren 1926); Caricetum rostratae Rübel 1912 ex Osvald 1923 em Dierssen 1982 (incl. Carici rostratae-Sphagnetum apiculati Osvald 1923 and Carici rostratae-Drepanocladetum fluitantis Hadac et Vana 1967) All. Caricion fuscae Koch 1926 em Klika 1934 Ass. Carici echinatae-Sphagnetum Soó 1934; Carietum nigrae (subalpinum) Br.–Bl. 1915 (incl. Junco filiformis-Sphagnetum recurvi Osvald 1923)
Active raised bogs	Carpathian raised bogs 7110-3	**Hummock vegetation** All. Oxycocco-Ericion (Nordhagen 1936) R.Tx. 1937 em. Moore 1968 Ass. Sphagnum papillosum (Scirpo austriaci-Sphagnetum papillosi (Schwick.1933) Moore 1968 All. Sphagnion magellanici Kästner et Flössner 1933 em. Dierssen 1975 Ass. Sphagnetum magellanici (Malcuit 1929) Kästner et Flössner 1933; Eriophoro vaginati-Sphagnetum recurvi Hueck 1925; Ledo-Sphagnetum magellanici Sukopp 1959 em. Neuhäusl 1969; (?) Trichophorum alpinum-Sphagnum compactum (= Sphagneto-Trichophoretum alpini Hadac 1956 nom. prov.)
		Hollow and lagg vegetation All. Rhynchosporion albae Koch 1926 Ass.Caricetum limosae Br.-Bl. 1921 (and: Sphagno duseni-Caricetum limosae Rudolph et al. 1928, Scheuchzerio-Sphagnetum cuspidati Osvald 1923); Rhynchosporetum albae Koch 1926; Eriophoro angustifolii-Sphagnetum recurvi Jasnowski et al. 1968 (and: Calliergo sarmentosi-Eriophoretum angustifolii Nordghagen 1927) All. Caricion lasiocarpae Vanden Bergh. ap. Lebrun et al. 1949 Ass. Caricetum rostratae Rübel 1912 ex Osvald 1923 em Dierssen 1982 (and: ? Carici rostratae-Drepanocladetum fluitantis Hadac et Vana 1967); Caricetum lasiocarpae Osvald 1923 em. Dierssen 1982 (incl. Carici filiformis- Sphagnetum apiculati Waren 1926) All. Caricion fuscae Koch 1926 em. Klika1934 Ass. Carici echinatae-Sphagnetum Soó 1934; Carietum nigrae (subalpinum) Br.–Bl. 1915 (incl. Junco filiformis-Sphagnetum recurvi Osvald 1923)

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Tab. 2b: Syntaxonomic position of vegetation of Polish mire habitats – Degraded raised bogs still capable of regeneration

Habitat type	Subtype & Natura 2000 code	Vegetation unit
Degraded raised bogs still capable of regeneration	7120	Order Erico-Sphagnetalia (=Sphagno-Ericetalia) (Braun-Blanquet 1948) em. Moore (1964) 1968 All. Oxycocco-Ericion (Nordhagen 1936) Tūxen 1937 Ass. Erico-Sphagnetum magellanici(Schwickerath 1933) em. Moore 1968; Erica tetralix comm. Order Sphagnetalia magellanici(Pawlowski 1928) Moore (1964) 1968 All. Sphagnion magellanici Kāstner et Flōssner 1933 em. Dierssen 1975 Ass. Eriophoro vaginati-Sphagnetum fallacis Hueck 1925; Eriophorum vaginatum comm. Order Cladonio-Vaccinietalia Kiell.-Lund 1967 All. Dicrano-Pinion Seibert in Oberdorfer (ed.) 1992 em. Initial and degeneratd stages of Vaccinio uliginosi-Pinetum Kleist 1929 ; outside of the system: Molinia caerulea comm.

Tab. 2c: Syntaxonomic position of vegetation of Polish mire habitats – transition and quaging mires

Habitat type	Subtype & Natura 2000 code	Vegetation unit
Transition and quaging mires	Lowland transition 7140-1 and quaging mires	Class Scheuchzerio-Caricetea nigrae (Nordhagen 1937) R. Tūxen 1937 Order Scheuchzerietalia palustris Nordhagen 1937 All. Rhynchosporion albae Koch 1926 Ass. Caricetum limosae Br.-Bl. 1921 (incl. subass. typicum; sphagnetosum fallacis); Rhynchosporetum albae Koch 1926 (incl. subass. typicum; sphagnetosum maji; sphagnetosum fallacis; cladopodielletosum fluitanstis); Eriophoro angustifolii-Sphagnetum recurvi Jasnowski et al. 1968 All. Caricion lasiocarpae Vanden Bergh. ap. Lebrun et al. 1949 Ass. Caricetum lasiocarpae Koch 1926 (incl. subass. typicum; sphagnetosum fallacis; campylietosum stellati); Caricetum rostratae Rūbel 1912 ex Osvald 1923 em Dierssen 1982 (incl. subass. with Sphagnum fallax = Carici rostratae-Sphagnetosum apiculati, in Polish literature also as Sphagno-Caricetum rostratae); Caricetum diandrae Jonas 1932 em. Oberdorfer 1957 (incl. subass. typicum; paludelletosum; scorpidietosum); Caricetum chordorrhizae Paul et Lutz 1941; Caricetum heleonastes (Paul et Lutz 1941) Oberdorfer 1957 All. Caricion nigrae Koch 1926 em. Klika 1934 Ass. Calamagrostietum neglectae Steffen 1931; Carici canescentis-Agrostietum caninae (Jonas 1932) R. Tūxen 1937 Outside of the system: Comm. Calla palustris; Menyanthes trifoliata; Comarum palustre
Transition and quaging mires	Mountain transition and quaging mires 7140-2	Class Scheuchzerio-Caricetea nigrae (Nordhagen 1937) R. Tūxen 1937 Order Scheuchzerietalia palustris Nordhagen 1937 All. Rhynchosporion albae Koch 1926 Ass. Caricetum limosae Br.-Bl. 1921 (=Sphagno dusenii-Caricetum limosae and Sphagno lindbergii-Caricetum limosae); Eriophoro angustifolii-Sphagnetum recurvi Jasnowski et al. 1968 All. Caricion lasiocarpae Vanden Bergh. ap. Lebrun et al. 1949 Ass. Caricetum lasiocarpae Koch 1926; Caricetum rostratae Rūbel 1912 ex Osvald 1923 em. Dierssen 1982 (=Carici rostratae-Drepanocladetum fluitantis and Sphagno-Caricetum rostratae) Junco filiformis-Sphagnetum recurvi Osvald 1923; Caricetum diandrae Jonas 1932 em Oberdorfer 1957 All. Caricion nigrae Koch 1926 em Klika 1934 Ass. Carici echinatae-Sphagnetum Soó 1934; Caricetum nigrae (subalpinum) Braun-Blanquet 1915; Carici-Agrostietum caninae (Jonas 1932) R. Tūxen 1937

the natural ones, and its annual amplitude is higher. Moreover the shape and the depth of the water table is adapted to the actual relief of the bog cupola and is dependent on the density and the depth of ditches. The secondary water conditions cause changes in the previous spatial vegetation structure of the bog cupola and establishing of the new vegetation pattern.

The secondary communities in the degraded raised bogs are not sufficiently recognized in Poland. The maintenance of at least some floristical connections with natural peatforming associations of the Oxycocco-Sphagnetea class is the general feature of their vegetation. Since the phytosociological material is scarce and rarely analyzed and classified in the proper way, the list of the associations and communities presented in Tab. 2 is provisional.

Phytocoenoses are significantly differentiated in respect of vertical and floristical structure. On the plateau of bog cupola their common feature is lack or insignificant share of hummock peatmoss species, which play a main role in the peat accumulation.

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Tab. 2d: Syntaxonomic position of vegetation of Polish mire habitats – Depressions on peat substrates (*Rhynchosporion*) lake-chalk and basiphilous mires ———— * syntaxon not included in the survey of MATUSZKIEWICZ (2001).

Habitat type	Subtype & Natura 2000 code	Vegetation unit
Depressions on peat substrates (*Rhynchosporion*)	7150	Class Scheuchzerio-Caricetea nigrae (Nordhagen 1937) R. Tüxen 1937 Order Scheuchzerietalia palustris Nordhagen 1937 All. RhynchosporionKoch 1926 Ass. Rhynchosporetum albae Koch 1926 (incl. Rhynchosporetum fuscae pro parte); Caricetum limosae Br.-Bl. 1921 forma nudum; comm. Carex rostrata forma nudum; Eriophorum angustifolium Outside of the system: comm.: Lycopodium inundatum; Rhynchospora alba; Drepanocladus fluitans; Drepancladus exannulatus
***Lake-chalk mires with *Cladium mariscus* and species of *Caricion davallianae* alliance**	7210	Class Phragmitetea R. Tüxen et Preising 1942 Order Phragmitetalia Koch 1926 All. Magnocaricion Koch 1926 Ass. Cladietum marisci (Allorge 1922) Zobr. 1935; Caricetum buxbaumii Issler 1932 Class Scheuchzerio-Caricetea nigrae (Nordhagen 1937) R. Tüxen 1937 Order Caricetalia davallianae Braun-Blanquet 1949 All. Caricion davallianae Klika 1934 Ass. Orchido-Schoenetum nigricantis Oberdorfer 1957 (=Schoenetum nigricantis)
Basiphilous mires	"Mountain flushes" 7230-1	Class Scheuchzerio-Caricetea nigrae (Nordhagen 1937) R. Tüxen 1937 Order Caricetalia davallianae Braun-Blanquet 1949 All. Caricion davallianae Klika 1934 Ass. Valeriano-Caricetum flavae Pawlowski(1949 n.n.)1960 (=Valeriano simplicifoliae-Caricetum flavae); Caricetum davallianae Dutoit 1924 em. Görs 1963
Basiphilous mires	Upland basiphilous mires of southern Poland 7230-2	Class Scheuchzerio-Caricetea nigrae (Nordhagen 1937) R. Tüxen 1937 Order Caricetalia davallianae Braun-Blanquet 1949 All. Caricion davallianae Klika 1934 Ass. Caricetum davallianae Dutoit 1924 em. Görs 1963; Ctenidio molluscae-Seslerietum uliginosae Klika 1943 em. Glazek 1983; Eleocharitetum quinqeflorae Lüdi 1921; Caricetum paniceo-lepidocarpae W. Braun 1968; Juncetum subnodulosi Koch 1926; comm. Schoenus ferrugineus (Fijalk. 1960) Palcz. 1964
Basiphilous mires	Spring- and percolating mires of northern Poland 7230-3	Class Scheuchzerio-Caricetea nigrae (Nordhagen 1937) R. Tüxen 1937 Order Caricetalia davallianae Braun-Blanquet 1949 All. Caricion davallianae Klika 1934 Ass. Orchido-Schoenetum nigricantis Oberdorfer 1957 (=Schoenetum nigricantis); *Campylio-Caricetum dioicae Osvald 1923 em. Dierssen 1982; * Eleocharitetum quinqueflorae Lüdi 1921; *Juncetum subnodulosi Koch 1926; comm. Schoenus ferrugineus (Fijalk. 1960) Palcz. 1964; *Carex buxbaumii comm. *All. Sphagno warnstorfiani-Tomenthypnion Dahl 1957 *Ass. *Sphagno warnstorfiani-Eriophoretum latifolii* Ryb. 1974 Order Caricetalia nigrae Koch 1926 em. Nordh. 1937 All. Caricion nigrae Koch 1926 em. Klika 1934 *Ass. Menyantho trifoliatae-Sphagnetum teretis Waren 1926 em. Dierss. 1982 Order Scheuchzerietalia palustris Nordh. 1937 All. Caricion lasiocarpae Vanden Bergh. ap. Lebrun et al. 1949 Ass. et SAss. Caricetum lasiocarpae Osvald 1923 em. Dierssen 1982; (incl. subass. typicum; campylietosum stellati); Caricetum diandrae Jonas 1932 em. Oberdorfer 1957 (incl. subass. typicum; paludelletosum; scorpidietosum)

The weakly peatforming hollow peatmoss species are lacking also or are not fully vigorous. On the bogs which have been only drained and to a small extend afforested or exploited for peat, the hummock-hollow complex is replaced by a dense hummocks vegetation. Such phytocoenoses are characterized by abundant development of *Calluna vulgaris*, *Ledum palustre*, *Erica tetralix* (along the coast only), *Eriophorum vaginatum*, brown mosses as *Aulacomnium palustre* (HEDW.) SCHWÄGR., *Dicranum polysetum* SW. ex anon., *D. scoparium* HEDW. and *Pleurozium schreberi* (WILLD. ex BRID.) MITT. Lichenes and dwarf pine also grow often on the tops of hummocks. In some cases *Eriophorum vaginatum*, *Sphagnum fallax*, rarely *S. cuspidatum* are the only remnants of the previous vegetation. On the edge of the plateau the initial stages of pine bog forest might develop. Along the ditches and places undergoing high water amplitude the plant cover is usually dominated by *Molinia caerulea*, which intensively develops after disappearance of pine trees, not adapted to the drastically lowered water table. The predominance of *Calluna vulgaris* and the small admixture of other species, for example brown mosses *Hypnum cupressiforme* HEDW. and *H. jutlandicum* HOLMEN & E. WARNCKE as well small lichens of the *Cladonia* genus are characteristic for drained and superficially burnt

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raised bogs. Generally the phytocoenoses can be divided into remnants of treeles peatmoss communities, peatmoss communities with significant trees share, heath and grass communities.

Vegetation dynamics

The artificial lowering of the water level has been the primary reason for the degeneration of vegetation, but such forms of anthropopressure as peat excavation, fires, afforestation, rarely pasturage have determined the present quality and spatial range of changes. Degraded raised bogs lack the lagg, instead they are usually surrounded by a drainage ditch. Their cupolas are dissected by ditches to enable peat excavation, carried out at different scale in the past.

The stratigraphical data from the degenered raised bogs of the Baltic type document undoubtly that these bogs have lost their main peatforming community with *Sphagnum fuscum* predominance. There are only scarce data on the rate and direction of changes in their secondary vegetation. Generally vegetation dynamics on newly dried bogs can be very fast in comparison to the bogs which have been drained since 100 years or more. However, for unknown reasons, the vegetation of bogs with old drainage systems can also change very rapidly, for instance from loose bog pine forest through *Ledum palustre* community to *Molinia caerulea* dominated phytocoenoses.

The renovation and clearing of ditches causes considerable deterioration of remants of typical flora and phytocoenoses. The vegetation along the ditches undergoes much faster and deeper changes, for instance the loose pine stands can rapidly decrease and be replaced by heath or blue grass aggregations. After relatively wet years, on the plateaus of some bogs bare peat between *Eriophorum vaginatum* hummocks have been rapidly overgrown by masses of *Rhynchospora alba* and the scarce growing low pine trees have declined evidently. Lack of renovation of drainage system and very few experiments of active protection have resulted in better development of raised bog species existing on the particular sites and inhibition of the invading trees as pine and birch.

Transition and quaging mires

Transition mires and quaging fens display an intermediate character between typical fens and bogs with respect to hydrological and trophic conditions as to the type and dynamic state of the vegetation. They are developing in places where as a consequence of peat growth a partial isolation of the mire surface from the influence of minerotrophic water appears and where rain water plays a substantial role in the mire water balance. The minerotrophic water that still reaches the mire is stagnant or moves very slowly. The pH is slightly or strongly acidic and the trophies status is low or very low. Consequently, the deficit of minerals and the acidification of peat substrate increases during further mire development. Transition mires are usually very wet. They are gradually developing during natural or enhanced terrestrialisation of lakes. Such mires can occur separately, or as a part of a mire complex, including large bogs, where a transition mire occupies a lagg zone or at the verges of pools on bog expanse.

In Poland transition mires are concentrated mainly within the young glacial landscape of the northern lowlands, especially in outwash plains in which melt-out depressions are common. In similar circumstances transition mires are found within morainic landscapes. In the mountainous region of southern Poland these mires are found mainly in the Sudety Mts. Besides their „classical" location in the margins of small pools of the subalpine bogs of Karkonosze and Izera Mountains, they are found on not very steep slopes within the upper forest belt (hanging transition mires) and on the river terraces of the Izera River and of larger streams (transition mires of river valleys). In the Tatra Mts. this type of mires is extremely rare. In Bieszczady their occurrence is limited to the lagg zones of some bogs. In the Podhale submontane region the remnants of transition mires are associated with some better preserved bogs.

The habitat has basically a natural origin, but sometimes it may develop under semi-natural conditions as a successional stage in peat cuts. Phytocoenoses of transition mires represent several plant communities of similar physiognomy, consisting of a flat

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carpet dominated by 1-2 species of vascular plants and usually a single species of *Sphagnum*. Some pioneer phytocoenoses consist of single- or two-species aggregations, encroaching over the open water surface. However, the majority of communities are stable in time, which enables the existence of a natural transition mire over a period of tens or hundreds of years. Then, a general rule of protection is to preserve the natural hydrological and trophic conditions.

Two subtypes of transition mire habitat have been distinguished in Poland: Lowland- and Mountain transition and quaging mires.

Lowland transition and quaging mires

The total area occupied by lowland transition mires is little. At each location the area of these mires does not exceed more than some tens to some hundreds of square metres. It is an important peat forming ecosystem, constituting part of larger mire complexes. The habitat represents extreme ecological conditions, only approriate for a limited number of species with narrow environmental ranges. Several are endangered, rare and protected species, some included in Polish Red Data Book (e. g. *Carex limosa*, *C. chordorrhiza*, *Hammarbya paludosa* (L.) KUNTZE, *Baeotryon alpinum*, *Chamaedaphne calyculata* and *Betula nana* – the only locality on lowlands). Moreover, relic species occur in these mires, at the border of their distribution area or on separated, „island" locations.

Although the vegetation of transition mires floristically is very differentiated, its structure is conspicuously uniform. Under natural and stable hydrological conditions it is always two-layered, consisting of mosses and herbs, while trees can establish themselves only occasionally and for a short period. The moss layer is predominated by peatmosses, occurring exclusively or in majority (in such case the moss layer is very dense), and some brown mosses. The moss layer is being reinforced by roots and rhizomes of vascular plants, which may cover from 5 % up to 90 % of the plot area. Usually the phytocoenoses are extremely poor in species, their number rarely exceeds 20. In both vegetation layers there is a strong domination of 1-2 species. For that reason the phytocoenoses have a physiognomy of (1) flat *Sphagnum* carpet with sparse occurrence of short cyperaceous species (e.g. *Eriophorum angustifolium*, *Rhynchospora alba*, *Carex rostrata*, *C. lasiocarpa*), (2) sedge lawn with *Sphagna*, (3) moss fen with sedges, (4) sedge vegetation with herbs (e.g. *Comarum palustre* L., *Menyanthes trifoliata* L.), (5) a floating raft of pioneer species encroaching over an open water (e.g. *Calla palustris*, *Comarum palustre*, *Menyanthes trifoliata*).

In lowlands the habitat is represented by at least nine plant associations in numerous subassociations and variants, as well as some plant communities poor in species. The syntaxonomical classification of this vegetation is far from complete and a general revision, also in eco-floristical and geographical respect, is required. The most important syntaxa in the group of very acidic *Sphagnum* carpets are Caricetum limosae (with or without *Scheuchzeria palustris*) and Rhynchosporetum albae, and in the group of very wet, slightly less acidic associations: Caricetum lasiocarpae and Caricetum diandrae, as well as the much rarer Caricetum chordorrhizae.

Vegetation dynamics

Phytocoenoses of natural origin are stable, and only evolve slowly in accordance with maturing and terrestrialising of water bodies. Communities in peat-pits are less persistent.

Artificial lowering of water level, depending on amount of change, accelerates the succession, leading to disappearance of submerged species, closing of the vegetation sward, and intrusion of bog flora, shrubs and trees. Yet, the speed and direction of these transformation is not well known.

Mountain transition and quaging mires

Transition and quaging mires in the mountains occupy extremely small area. They are relatively more common in the Sudety Mountains. In „classical" form i.e. as swinging *Sphagnum* carpet associated with lakes they are extremely rare, and are found around Toporowy Staw in the Tatra Mts. and by small pools on the subalpine mires in

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the Karkonosze and Izera Mts. More commonly transition mires accompany bogs (usually in the lagg zone). Such examples are found in the Bieszczady Mts., in the bog Bór na Czerwonym near Nowy Targ and at the outskirts of subalpine mires. Sometimes transition mires form an element of other mire systems. For example they form enclaves within soligenous mires „hanging" on slopes of several mountain ranges in the Sudety Mts. and on the terraces of rivers in the Izera Mts. Mires found in the Karkonosze and Izera Mts., which receive larger amount of ground water, are classified as oligo-minerotrophic, due to very low concentrations of nutrients transported by these waters.

The vegetation of mountain transition mires has the similar physiognomy as the ones on lowlands. Phytocoenoses are built mainly by dense carpets of *Sphagnum* mosses (more rarely by brown mosses), in most part submerged in water. Herb layer is composed of loosely growing (mostly cyperaceous) species, such as *Carex rostrata*, *C. limosa*, *C. nigra*, *Eriophorum angustifolium* and *Juncus filiformis*. Normally, plots are built by only few species, 1 or 2 of which dominate in each vegetation layer.

The habitat is represented by 10 plant associations, of which characteristic for Karkonosze are Sphagno dusenii-Caricetum limosae, Sphagno lindbergii-Caricetum limosae and Carici rostratae-Drepanocladetum fluitantis, while Junco filiformis-Sphagnetum recurvi, Calliergo sarmentosi-Eriophoretum angustifolii and Caricetum nigrae subalpinum occur in both the Karkonosze and Izera Mts. The remaining associations, especially Sphagno-Caricetum rostratae and Eriophoro angustifolii-Sphagnetum recurvi occur in all Polish mountain ranges and in the Podhale region.

Vegetation dynamics

The natural speed of transformations, related to peat accumulation and development of new ecological conditions, is very slow. It can be increased, when a rapid hydrological change occurs on sloping mountainous areas, for example due to sliding of peat deposit, or to qualitative changes in water supply.

The development of the mountain transition mires lasted for thousends of years and was stimulated by changes in climatic conditions towards a wet and relatively warm climate. Particular mire types could have formed in different climatic periods, for example subalpine mires in Sudety have developed during the climatic optimum, while the hanging mires are much younger.

The present changes are definitely of anthropogenic origin. The hydrological system of part of mountain mires in the Sudety Mts. is severly disturbed as a result of previous drainage and the present-day disaster caused by acid rains. The latter have contributed to hydrological changes by massive destruction of mountain spruce forests. As a consequence upper peat layers have been dessicated, mire species were substituted by such species as *Deschampsia flexuosa* (L.) TRIN., *Molinia caerulea* and *Calamagrostis villosa* (CHAIX) J.F. GMEL. Reduction of the pollution seems to progress well, however the full regeneration of mire vegetation will take a very long time. The potential threat for mires is liming and fertilizing of adjacent forests and areas planned for afforestation.

Depressions on peat substrates (Rhynchosporion)

This natural or semi-natural habitat forms one of the elements of spatial complex of raised bogs and wet heathlands. On shores of lakes it occupies ecotone zone outside of the high water level mark. The vegetation is composed of a very limited number of sparsely distributed species. Large proportion of these species are weak competitors, demanding a space free of other plants for proper development. Phytocoenoses are either ephemeral or more stable. They occur on peat, shalow peat with sand or on sand with only a little admixture of amorphic humus. Usually very wet sites may dry-out superficially in dry years. The soil pH ranges between 5 and 4.

Few phytocoenoses known from literature, which may represent the habitat, are only partially classified as associations; sometimes they represent the one species' aggregations. The remaining syntaxa represent plant communities of undetermined syntaxonomic position. The existing mate-

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rial still needs supplementation and synthesis, thus the vegetation classification system, presented in Tab. 2, has a temporary character.

Polish data on vegetation of this mire habitat are so scarce, that only a generalised description of physiognomy and structure of phytocoenoses can by presented. The communities are at most two-layered, built by very little number of flowering plants (sometimes by a singular species), such as *Rhynchospora alba*, *R. fusca*, *Drosera intermedia*, *D. rotundifolia*, *Erica tetralix* and *Carex rostrata*. The plants grow loosly and are intarspaced by infrequent algae, hepatics (e.g. *Fossombronia doumortieri* (HÜB. & GENTH.) LINDB., *Gymnocolea inflata* (HUDS.) DUM.) peat mosses (*Sphagnum compactum*), brown mosses and club-mosses (*Lycopodiella inundata*).

There are certain differences between phytocoenoses occurring on exclusively peaty substrate and those growing on sand with different layers of amorphous humus. In lowland sites with peat substratum the occurrence of *Rhynchospora alba* is more common, while *R. fusca* (a species very rare in Poland) is found more often on sandy habitats. The vegetation plots considered as most typical were described as the community with *Lycopodium inundatum (Lycopodiella inundata)* and, partly, as Rhynchosporetum fuscae. It is possible that some of the succesional stages found in the interdune depressions are also representative for the habitat. The phytocoenoses from erosion gullies in the subalpine mires in Karkonosze are described as Caricetum rostratae forma nudum, Caricetum limosae fo. nudum, community with domination of *Eriophorum angustifolium* and the communities of *Drepanocladus fluitans* and *D. exannulatus* (= *Warnstorfia exannulata* (SCHIMP.) LOESKE).

Vegetation dynamics

The phytocoenoses are partly of a secondary origin and of pioneer character. There were no studies of their dynamics. It is supposed that the vegetation of erosion gullies may persist for relatively long time, except of some catastrophic events. On the other hand places which originate due to animal activity are colonised by pioneer species for a shorter period of time, and regenerate relatively fast to vegetation typical for a particular part of the mire. The plots with *Rhynchospora fusca* in wet interdune depressions after 30 years of passive protection have lost most of the area and were substituted by low bushes of *Myrica gale*. Phytocoenoses with *Lycopodiella inundata* which develop in wet heathlands on exposed sand, are especially short-living.

Lake-chalk mires with *Cladium mariscus* and species of Caricion davallianae alliance

Lake-chalk mires with tall emergent vegetation have formed in the course of natural succession taking place in the litoral zone of water bodies (mainly meso- and eutrophic lakes, rarely dystrophic lakes) and on lake chalk deposits of terrestrialised lakes, sometimes with a considerable peat layer. In many cases the development of lake-chalk mires have been accelerated by artificial lowering of lake water. Origin of some mires is different, and related to calcareous rocks of much older age.

The total area occupied by the lake-chalk mires in Poland is small. Their size ranges from less than 1 ha to several hundred hectares, but the big ones are relatively few.

In respect of water supply the majority of the mires represent a topogenic hydrological type, however the supply with laterally flowing groundwater in the zone adjacent to mineral margin, is often found. This allows the succession of mire vegetation towards a moss-sedge dominated percolating (soligenous) fens. Water level in lake-chalk mires is generally above the surface and oscillates considerably throughout the year. The mires display usually the mesotrophic conditions. Soils are rich in organic matter, have pH range of 5-8, moderate to high trophy and can be slightly "salty".

The position of lake-chalk mires in the landscape may be different. At the lake shores they form a thick floating mat responding to changes in lake water level (emersive mires). They are also found in the immersive-emersive zone where root system of tall rush vegetation is anchored in semi-liquid organic sediments. In such places wa-

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Photo 55: *Schoenus nigricans* in the lake-chalk mire at the shore of Miedwie Lake, NW Poland. (Photo L. Wolejko)

ter depth rarely exceeds 0.5 m. Water levels oscillate, falling, in extreme cases to 1 m below the mire surface. Further inland the lake-chalk mires extend to the zone of moss-sedge vegtation. In completely terrestrialised basins and in rocky depressions the position of lake-chalk mire vegetation is related to the average water level.

Photo 56: *Orchis palustris* in the lake-chalk mire at the shore of Miedwie Lake, NW Poland. (Photo L. Wolejko)

The floristic composition and physiognomy of plant communities of the mires is variable in relation to water depth and amplitude, nutrient availability, depth of the organic layer, adjacent vegetation, successional stage, and type of land management.

All emergent types of phytocoenoses with dominant *Cladium mariscus* are considered to represent the lake-chalk mire habitat type. The phytocoenoses are well distinguishable from all other tall rush communities. Another typical association is Caricetum buxbaumi, spatially connected with *Cladium* communities and occupying similar sites. This community, however, is very rare in the country and insufficiently studied. There is a possibility that either part of phytocoenoses or a whole syntaxon should be placed within the moss-sedge vegetation of Caricion davallianae alliance. Another association of this alliance – Schoenetum nigricantis (Orchido-Schoenetum nigricantis) is found on lake-chalk mires in places not infuenced by moving groundwater.

Closed swards are built by a single dominant – *Cladium mariscus*, reaching 2 m in height. They are easily recognisable due to peculiar gray-bluish color and serrate leaves of *Cladium*. A few other helophytes: *Thelypteris palustris* Schott, *Phragmites australis* (Cav.) Trin. ex Steud., *Equisetum fluviatile* L., *Lycopus europaeus* L. and *Lythrum salicaria* L., usually have only a small coverage. Floristically richer phytocoenoses, representing a moss-rich variant, contain bryophyte species, such as *Scorpidium scorpioides*, *Campylium stellatum* (Hedw.) Lange & C.F.O. Jensen, *Tomenthypnum nitens* as well as some herbs, for example *Menyanthes trifoliata* and *Juncus articulatus* L. em. K. Richt.

Cladium mariscus has a relatively wide ecological amplitude, which is the reason for the internal division of the community into several variants: 1) typical (very poor in species, found in the litoral zone of lakes), 2) calciphilous (sometimes described as a mossy variant) usually found on a peat covering the gyttia deposits of recently terrestrialised lakes, 3) acidophilous (much rarer, found mainly in outflowless depressions with dystrophic lakes and adjacent acidic bogs, in the regions dominated by poor, sandy soils; 4) halophytic (described only

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from the Wolin Island). Phytocoenoses with sparse, short and sterile individuals of *Cladium* should be treated as terminal or denerative stages of the community (JASNOWSKI 1962, PIOTROWSKA 1966, JASNOWSKA et al. 1991, 1993).

Phytocoenoses with *Carex buxbaumii* WAHLENB. are richer in species. Moss layer is variable, covering from 5 to 95 % of plot's area. The localities of Caricetum buxbaumii are known only from the shores of Miedwie Lake (environs of Szczecin) (JASNOWSKI 1962, BACIECZKO 1996), from Suwalki Lakeland (JUTRZENKA-TRZEBIATOWSKI & SZAREJKO 2001) and from the Leczna-Wlodawa Lakeland (FIJALKOWSKI & CHOJNACKA-FIJALKOWSKA 1990). The phytocoenoses of these regions contain a large number of typical calciphilous species and elements of meadow vegetation.

In shortly inundated sites phytocoenoses with *Carex buxbaumii* and a domination of meadow (*Molinia caerulea*, *Lysimachia vulgaris*) and fen species, like *Carex fusca*, *C. hostiana* DC., *Schoenus ferrugineus* L. may constitute an element of a Molinion meadow or basiphilous mire habitat.

Physiognomy of Schoenetum nigricantis is dominated by the tussocks of *Schoenus nigricans*, growing with different density. Other, not very numerous species include *Carex lepidocarpa* TAUSCH and *Molinia caerulea*. Moss layer is usually poorly developed.

Schoenetum nigricantis is internally divided into 4 forms of still uncertain rank: The typical form with domination of *Schoenus nigricans* (Photo 55), a form with dominating *Carex lepidocarpa* (both are characterised by wet depressions with *Eleocharis quinquaeflora* (HARTMANN) O. SCHWARTZ), a form with *Phragmites australis*, occupying slightly drier places and a form with *Molinia caerulea* on wetter substrates. The latter form is rich in orchid species: *Dactylorhiza majalis* (RCHB.) P.F. HUNT & SUMMERH., *D. incarnata* (L.) SOÓ, *Orchis militaris* L., *O. palustris* JACQ. (Photo 56) and *Epipactis palustris* (L.) CRANTZ. The distribution of the typical association of Schoenetum nigricantis is restricted only to Myślibórz Lakeland (NW Poland). In different regions of Poland *Schoenus nigricans* is a part of several other plant communities (e.g. ZABAWSKI & MATULA 1976, GLAZEK 1989, SZELAG 2001).

Vegetation dynamics

According to palaeobotanical records, *Cladium mariscus* was in the past a common element of rush vegetation in the river valleys, which are now filled with deep peats. At present *Cladium mariscus* is found almost exclusively at lake-side localities. The decline of that vegetation type has been a long and widespread process, related to natural evolution of lakes and wetlands, but the present day changes must be attributed to human activities, such as drainage, afforestation, burning, trampling and excessive grazing. Small sites of the community may be affected by eutrophication and pollution from chmicals used in the surrounding agricultural areas.

In case of artificial lowering of lake water level or due to the dropdown of regional waterhead, the *Cladium* vegetation degenerates quite rapidly. The density of sward decreases on benefit of tall sedges and mosses (the latter at first are calciphilous and neutral, later acidophilous, including pioneer *Sphagnum* species). Drying out places with changable water level may be overgrown with *Molinia caerulea* and *Calamagrostis epigeios*. Similar results are produced by irregular burning. In phytocoenoses sporadically mown or grazed in the past the shrubs, mainly willows and *Alnus glutinosa* (in the coastal zone also *Myrica gale*) may appear after abandonment of agricultural practices (JURZYK 2004).

It has been estimated than more than half of the original areal of *Cladium* vegetation has been destroyed. There are, however, documented cases of restoration of Cladietum marisci after rising up of the groundwater level.

Even more severe changes are observed in the case of Caricetum buxbaumii. For example, during the last 35 years, the area of this community near the Miedwie Lake (NW Poland) has decreased from ca. 1.000 m^2 to only 50 m^2 (BACIECZKO 1996).

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Basiphilous mires

According to landscape-ecological criteria (SUCCOW 1988) basiphilous fens represent the soligenous mires i.e. mires supplied with moving groundwater. The chemical composition of such waters varies considerably and the amount of dissolved ions (including Ca++) differs in relation to the type of rocks encountered by water on its passage to mires and in relation to residence time of this water in the ground. The amount of dissolved calcium plays a major role in controlling the pH of the mire habitat. The pH of surface layers of basiphilous mires is usually within the range of 6.5 to 8.

The groundwater levels in undisturbed basiphilous fens are usually high and oscillate close to mire surface or are sometimes seeping out and then filling-up small depressions or ponds. In growing moss-sedge percolationg fens the groundwater is transported through the upper layers of mire in the direction of rivulets or outflows (e.g. karst holes). All basiphilous mires are sloping to some extent (some considerably so), and thus, in the case of concentrated surface flow, are prone to erosion.

Basiphilous fens in Poland occur in three landscape-related geomorphological forms: as hanging mires, spring mires and percolating mires.

Hanging mires are found on relatively steep slopes in places, where only a shallow layer of peat can accumulate (usually only a layer of gleyey soil is formed).

Spring mires are found in various topographical situations, where a long-lasting, continuous supply of groundwater occurs. The spring water reaching mire surface is sometimes under a considerable hydraulic pressure. Well developed spring mires have a distinctive shape, usually resembling a regular cupola or an elongated hill. These structures originate through the alternating or simultaneous accumulation of peat and travertine. The latter is composed mainly of calcium carbonate, but admixtures of magnesium and iron are also commonly found.

Percolating mires usually start at the lower part of slopes of the ice-marginal valleys, river valleys and lake basins. With the passage of time they can grow large and fill virtually the entire valley space. The most prominent percolating mire system is found in the upper and lower basins of the Biebrza river valley in North-eastern Poland.

The size of basiphilous mires ranges from less than 1 ha to several tens or, rarely, few hundred hectares. They often constitute a part of larger peatland areas, which are highly differentiated in respect of water regime, trophy and vegetation. Plant communities of basiphilous mires proper are usually bordered by spring, poor fen or bog vegetation, as well as by reeds or wet meadows in more disturbed situations.

Phytocoenoses of basiphilous mires display remarkably similar physionomy but there is a high degree of variability in their botanical composition, which can be related to differences in water chemistry, dynamic state of vegetation and the geographical range of particular mire species. Within the country the phytocoenotic diversity decreases towards the north and with growing height in the mountains. The typical plant communities are either of natural origin or human induced. In the latter case their occurrence can be related for example, to human interference with hydrology (drainage or damming of watercourses), changes in catchment management (e.g. deforestation), grassland use (mowing) or peat exploitation. Under disturbed conditions the dynamics of vegetation is very high. The successional changes lead to the development of meadows or shrub communities, acidic moss fens, and eventually to transition *sphagnum* bogs. Cases of succession which degrade the calciphilous vegetation are well documented for some nature reserves (KUCHARCZYK 1996, BERDOWSKI & PANEK 1998, TOMASZEWSKI 1998, BARANIAK et al. 2003) but attempts of their restoration are very few (HOLUK 1996).

The division into subtypes is based on geographical (regional) character of basiphilous mires. It is associated with the variation of topographical, geological and geohydrological conditions, the age of the landscape and the landscape-forming processes. This variation is reflected also in the vegetation of the mires. The three distinguished subtypes are: "Mountain flushes"; Upland basiphilous mires of southern

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Poland and Spring- and percolating mires of northern Poland.

"Mountain flushes"

"Mountain flushes" are permanently wet places on mountain slopes, supplied with moving groundwater that reaches the ground surface in form of non-concentrated seepage. Water is usually rich in calcium as the underlying strata often contain limestone or flysh rocks. Impeded outflow of water results in ground paludification and enable accumulation of shallow peat layers or the peaty-gleyey soils (PAWLOWSKI et al. 1960).

Mountain flushes are rather common in the Carpathian Mountains (especially in the lower mountain forest belt) and less frequent in the Sudety Mts. The mires are usually small. These natural, weakly peat-forming ecosystems are life habiatats of the large number of plant species listed among the rarest and most endangered elements of Polish flora (e.g. *Primula farinosa* L., the only lacality of which in the country is found on mountain flush in the Beskid Sadecki Mts. (ZABOKLICKA 1964). Although considered originally natural ecosystems, mountain flushes expanded in size and numbers as a result of human influence – deforestation of the catchments and consequently increased groundwater supply. At present they are commonly used as hay meadows, but of rather inferior quality (STUCHLIKOWA 1967, PIEKOŚ-MIRKOWA & MIREK 1996).

The phytocoenoses of mountain flushes form dense two-layered swards, sometimes with small, more open spots, where water seeping through vegetation is visible. The upper layer of vegetation is composed of numerous species of sedges, baldrians, lady's mantles, orchids and other herbs. Moss layer is always well developed, occupying usually 80-95 % of the plot. Localities of the mires are standing out of the surrounding meadow complexes due to conspicuous white inflorescenses of *Eriophorum latifolium* HOPPE (Photo 57).

The plant community is displaying high variability. Depending on local environmental conditions the phytocoenoses related to spring vegetation (Montio-Cardaminetea class) or to mires of Caricetalia nigrae alliance may develop (HÁJEK 1999).

Photo 57: Mountain flush with *Eriophorum latifolium*. (Photo L. WOLEJKO)

Vegetation dynamics

Typical plant communities of mountain flushes are stable under conditions of continuous, extensive use. Main reasons for degradation and eventual disappearance of the mires are drainage, water winning, and locally, the growth of urban areas.

Upland basiphilous mires of southern Poland

Typical, well developed basiphilous mires of this subtype have a form of extensive cupolas „hanging" at the slopes of submontane valleys of southern Poland. The size of such mire is controlled by the spatial extent of influence of groundwater supplying them. The waters are permanently close to mire surface, undergoing only minor fluctuations throughout the year. Due to autogenic or human-induced processes in some places groundwater appears at the mire surface in form of springs or small pools, usually collected in a cascade-like systems. In such places the most intense precipitation of calcium carbonate takes place, resulting in deposition of the travertine layers in peat profile. Vegetation is mostly mesotrophic, but local drainage, both due to natural and anthropogenic reasons, leads to mineralisation of peat and allows the patchy development of more eutrophic vegetation types (e.g. tall-sedge vegetation). The vegetation of the best preserved mires shows mosaic-like structure of

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calciphilous plant communities, pools with *Chara spp.*, springs (Cratoneurion), pioneer communities and the peat-forming moss-sedge communities belonging to Caricion davallianae alliance, tall-sedge communities along the water trails, and the complex of tall forb – arboreal vegetation along the erosion gullies. At present such patterns are often disturbed by human activity and the vegetation is enriched with meadow communities (Calthion) on soils containing larger proportion of mineral particles, or meadow type of Caricion davallianae communities on more peaty substrates. Calcareous sites drained more severly may transform into Molinion meadows or even thermophilous grasslands.

Basiphilous mires of the Leczna-Wlodawa Lakeland and the environs of Chelm (south-western Poland) developed within an older landscape, which has been reshaped for ca. 230 000 years. Their development is associated with hydrogeological phenomena which are also responsible for the development of lake-chalk mires. Both mire types form spatial complexes and occur in places allowing continuous supply of base-rich waters. In the landscape concerned these are usually margins of chalk basins, and „hydrological windows" in valley bottoms (ALEXANDROWICZ & ZUREK 1996) often associated with tectonic faults and karstic processes (e.g. DOBROWOLSKI 1998).

Similar situation exists in the Leszno Lakeland – another region of lake-chalk mires concentration, situated in central Poland. There typical soligenous mires are rare, and basiphilous fen ecosystems are found at the margins of terestrialised lakes and on the secondary habitats (KACZMAREK 1963). In central and western Poland basiphilous mires are infrequently found in river valleys or depressions of another origin, always within the landscapes rich in in base containing rocks (gypsum, limestone). In this part of the country the habitats of basiphilous mires have been strongly transformed due to human impact. Present soils have developed from transformed fen peats, sometimes occur also deluvial soils – a reminder of intensive erosion processes that took place after deforestation of the catchments (GLAZEK 1984, 1989).

Caricetum davallianae is the most typical and frequent plant community of the basiphilous mires of southern Poland (e.g. JARGIELLO 1976, KWIATKOWSKI 1997, BERDOWSKI & PANEK 1998, KUCHARSKI 1998). Davall's sedge, a characteristic and dominant species of this community forms small tussucks with characteristic, upright shoots and standing out spicklets. Among the tussocks regularly occur other small sedges: *Carex flava* L., *C. panicea* L. and *C. nigra*. Other frequent calciphilous species include *Carex dioica*, *C. hostiana* and *C. lepidocarpa*, several herbs and mosses, especially of genera *Drepanocladus*, *Campylium* and *Bryum*. The upper layer of community is formed by conspicuous fruiting shoots of cottongrass species: *Eriophorum latifolium* and *E. angustifolium* together with tall flowering shoot of thistles – *Cirsium palustre* (L.) SCOP, *C. rivulare* (JACQ.) ALL. and *C. canum* (L.) ALL.

Ctenidio molluscae-Seslerietum uliginosae is a floristically rich (up to 50 species per plot) plant community (GLAZEK 1984). It has an appearance of short grassland, as it is dominated by a tussock-forming grass *Sesleria uliginosa* OPIZ. Characteristic species of this community include also *Carex hostiana*, *Polygala amarella* CRANTZ and the moss – *Ctenidium molluscum* (HEDW.) MITT. A peculiar physiognomy of this community is a result of contrasting combination of bluish shots of *Sesleria* and short, dense tussocks of *Carex davalliana*. With the two co-dominants there is a constant presence of other typical floral elements of basiphilous mires (e. g. *Eriophorum latifolium*, *Parnassia palustris*, *Epipactis palustris*, *Carex panicea*). Sometimes mass occurrence of calciphilous mosses: *Campyllium stellatum*, *Limprichtia revolvens* (Sw. ex anon.) Loeske in Nitardy (=*Drepanocladus revolvens* (SW.) WARNST.) and *Fissidens adianthoides* HEDW. is observed. Usually presence of wet meadow species is also pronounced, the most common of them are *Equisetum palustre* L. and *Cirsium rivulare*.

Phytocoenoses with *Schoenus ferrugineus* (described as *Schoenus ferrugineus* community, Schoenetum ferruginei or Lipario-Schoenetum ferruginei) are recorded at calceraous lake-side sites, which are somtimes

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disturbed and have a changing water lavel and as a succession stage substituting pioneer communities of Eleocharitetum quinqueflorae, Cladietum marisci or Schoenetum tabernaemontani. Near Busko (south-central Poland) a community has a two layered structure build by *Schoenus ferrugineus* and mosses (covering from 80-100% of plot). Characteristic species are *S. ferrugineus*, *Liparis loeselii* (L.) RICH. (Photo 58), *Tofieldia calyculata* (L.) WAHLENB. and *Pinguicula vulgaris* L. (GLAZEK 1992). Other species of Caricion davallianae form a constant component of the community. An interesing feature is a stable presence of rush vegetation elements, such as *Phragmites australis*, *Schoenoplectus tabernaemontani* (C.C. GMEL.) PALLA and *Eleocharis palustris* (L.) ROEM. & SCHULT.

The natural peat-forming sedge-moss communities of basiphilous mires produce and accumulate a moderate amount of biomass and mineral precipitates. They are a habitat of several extremely rare, endangered and protected species of Polish flora such as: *Schoenus nigricans*, *S. ferrugineus*, *Liparis loeselii*, *Carex davalliana*, *C. pulicaris* L., *Orchis palustris*, *Sesleria uliginosa*, *Eleocharis quinquaeflora*, *Swertia perennis* L., *Pinguicula vulgaris* subsp *bicolor* (WOL.) Á. LÖVE & D. LÖVE, *P. vulgaris* subsp *vulgaris*, *Polygala amarella*, *Tofieldia calyculata*, *Tomenthypnum nitens*. Two species: *Liparis loeselii* and *Ostericum palustre* BESSER (= *Angelica palustris*) are listed in Appendix II of the Habitat Directive of the EU.

Vegetation dynamics

Cupola-shaped mires in uplands and submontane areas sometimes udergo changes or even disappear completely due to erosion processes, induced by ecohydrological dynamics.

Places drained by man and withdrawn from agricultural management undergo secondary succession leading to the development of shrubs and forest (mainly alderwood). It may also turn to grass communities dominated by *Calamagrostis epigeios* (L.) ROTH, *Arrhenatherum elatius* (L.) P. BEAUV. ex J. PRESL. & C. PRESL. and *Elymus repens* (L.) GOULD (= *Agropyron repens* (L.) P. BEAUV.). Mineralisation of drained peat promotes the invasion of such nitrophilous species as *Urtica dioica* L., *Galium aparine* L. or *Sambucus nigra* L. Under conditions of disturbed hydrology the mire vegetation is substituted by rush, tall forb, shrub and forest communities. There is a possibility of partial compensation and controlling the succession by extensive mowing (at least once in two years in late summer, with removal of biomass). In practice the dynamic and changes in these phytocoenoses in Poland are unsufficiently studied.

Photo 58: *Liparis loeselii* in a calcareous fen at Lake Ratno, Western Poland. (Photo A. SZAFNAGEL-WOLEJKO)

Spring- and percolating mires of northern Poland

Originally, large complexes of percolating mires filled the valleys of many smaller rivers of northern Poland. At present mires in the Biebrza valley (see Photo 32) belong to most extensive and the best preserved, not only for Polish standards, but also in the scale of whole central Europe (e.g JASNOWSKI 1975, PALCZYŃSKI 1975, HERBICH 1994, WOLEJKO 2000).

The size of individual mires differs considerably – from small ones covering a few

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Photo 59: Patches of *Paludella squarrosa* in the soligenous fen in the upper basin of Biebrza mire, NE Poland. (Photo L. WOLEJKO)

hectares in small river valleys to several hundred hectares large complexes in the Biebrza valley (especially in the so-called Upper Basin of this river). There they occupy the upper part of the valley slope, isolated from river floods. The mire is sloping in the direction of the river. Large amounts of groundwater feed the mire in unconcentrated way, and, following the slope inclination flows through the upper peat layers towards the river. The groundwater level is always high, and varies little, even during a multiyear cycle. Such situation is in part a result of the immersive nature of the mire surface, which oscillates (floats up and down) and adjusts to the present waterlevel.

The main body of peat deposit usually consists of weakly and medium decomposed moss and sedge peats. In places, more actively supplied with upwelling water, spring cupolas may form, which are partly composed of calcareous travertines. These local spring mires may be overgrown and „buried" in peat by developing percolating fen.

The pH of the upper layers of peat ranges between alkaline and slightly acidic. The places where rapidly growing mire surface "escapes" from the influence of calcareous groundwater are colonised by pioneer, weakly acidophilous species. They start a new successional series, leading to the development of bog communities. The mires, as other basiphilous fens, represent mesotrophic conditions.

Plant communities forming a vegetation cover of soligenous mires of northern Poland are numerous and diversified in respect of physiognomy, botanical composition and some abiotic conditions (esp. the pH). Untill now, no less than 20 syntaxa at the rank of plant community have been described (Tab. 2), most of them has not yet been accepted generally and incorporated into phytosociological system of the country (e.g. MATUSZKIEWICZ 2001). In all cases they are two-layered communities. The upper layer is formed by monocotyledon plants (mostly low or middle sized sedges and, infrequently, grasses) and a limited number of other herbs, which often don't add-up to cover the entire plot. The brown moss layer is almost always very dense.

The most extensive phytocoenoses of basiphilous and neutral mires exist in the Biebrza valley. They are differentiated into several plant communities which are occupying different zones across the valley in cor-

Photo 60: Rich fen vegetation threatened by forest succession in the calcareous mire "Bagno Chlopiny", NW Poland. (Photo L. WOLEJKO)

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respondence to different chemical composition of waters reaching these zones. Outside of that region, basiphilous mire communities occupy much less area. Some of them have a specific physiognomy, such as the exemplary communities described below.

Eleocharitetum quinquaeflorae is a pioneer community occupying very wet depressions with exposed peat. It is the most common, typical community of calacareous mires in northern Poland (TYSZKOWSKI 1993), found mainly in basins of terrestrialising lakes, while in southern Poland it is also present on spring cupolas of basiphilous mires (see above). Typical plots of the community are dominated by brown mosses (mainly *Drepanocladus intermedius* and *Campyllium stellatum*) and their characteristic physionomy is formed by short and loose swards of *Eleocharis quinquaeflora* and small sedges of the *Carex flava* group (*C. lepidocarpa*, *C. flava* and *C. viridula* MICHX.). Frequent herbs include *Pinguicula vulgaris*, *Tofieldia calyculata* and, in the mountains, also *Equisetum variegatum* SCHLEICH. Usually, the size of phytocoenoses is small, ranging from few square dicimetres to several square metres.

Juncetum subnodulosi is a plant community that rarely occurs in northern Poland in it's typical form i.e. in combination of characteristic species of Caricion davallianae alliance (MARKOWSKI & STASIAK 1988, WOLEJKO 2000). The few still remaining typical sites are associated with lake-chalk mires that are in part fed laterally with calcareous spring water. Relatively more common are „relic" sites still existing in soligenous mires transformed by human use. The community encountered there, called Crepido-Juncetum subnodulosi represents a wet meadow alliance – Calthion. Due to biology of *Juncus subnodulosus* SCHRANK, which forms dense, tall, brownish-green swards, the plots of this community distinguish itself well from the surrounding meadow vegetation. Besides a numerous species of wet meadows, the orchids such as *Dactylorchiza majalis* and *D. incarnata* are often found in the phytocoenoses of Crepido-Juncetum subnodulosi. The moss layer is dominated by genera prefering rather eutrophic conditions, such as *Plagiomnium*, *Calliergonella* and *Brachythecium*.

Photo 61: Ditch overgrowing with *Hottonia palustris*. "Bagno Chlopiny", NW Poland. (Photo L. WOLEJKO)

Menyantho-Sphagnetum teretis is a plant community physiognomically characterised by the presence of *Menyanthes trifoliata*, accompanied by e.g. *Equisetum palustre* and *Carex nigra*, and sometimes *Epipactis palustris*. A conspicuous feature is the presence of so called „relic" mosses: *Tomenthypnum nitens* and *Paludella squarrosa* (Photo 59) as well as some calcitolerant *Sphagnum* species, as *Sphagnum teres* (SCHIMP.) ÅNGSTR. and *S. warnstorfii* RUSSOW (HERBICH 1994, WOLEJKO 2000).

Some phytocoenoses built by *Carex lasiocarpa* and *Sphagna* belong to the transition bog habitat (acidic). Plots with *Carex diandra* SCHRANK on very loose, watery substrate represent early terestrialisation stages of lakes. Certain phytocoenoses with *Carex buxbaumii* and *Juncus subnodulosus* may represent wet meadow vegetation.

Spring- and percolating mires are very active peat-forming ecosystems, regulating

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Photo 62: Ditch in the spring fen overgrowing with *Carex paniculata*. Drawa National Park, NW Poland. (Photo L. Wolejko)

and stabilising water flow in the valleys of northern Poland. The mires are a habitat for more than 400 species of vascular plants and ca. 80 species of mosses. More than 60 plant species are protected, endangered or rare. Two species: *Liparis loeselii* and *Saxifraga hirculus* L. are listed in Appendix II of the Habitat Directive of the EU.

Vegetation dynamics

The vegetation of soligenous mires had optimal development period before the massive drainage works commenced in northern Poland in the 18th century. Massive, more or less uniform layers of moss peat found in percolating mires (especially in the Biebrza valley) point to long periods of undisturbed existence of the particular types of phytocoenoses. Restricted mowing of undrained mires in only a very limited way affected their vegetation. In that time cupolas of spring mires may have undergone spontaneous transformations, typical for these mires. In general, short-time use associated with weak drainage often enabled the spontaneous regeneration of peat-forming vegetation. When the proportion of ground- surface- and precipitation water reaching mire surface changes, the natural succession of soligenous mires leads towards acidification and eutrophication.

Human-induced change in hydrological conditions (water-level drop, change in direction and intensity of groundwater flow) in the recharge areas always affects the vegetation of soligenous mires. It is reflected in the encroachment of woody species, reduction of peat-forming abilities, and in the extreme cases in peat mineralisation and invasion of nitrophilous species (Photos 60 – 62). In case of withdrawal of mowing soligenous mires in sub-optimal state are rapidly overgrown by willows and birches. The transitional stage is formed by the development of tussock-forming sedge and grass communities (*Carex appropinquata* Schumach., *C. cespitosa* L., *Molinia caerulea*) or tall-forb communities (e.g. with *Trollius europaeus* L.).

Current state and needs of mire protection in Poland

The practical protection of mires and peatlands in Poland is realised mainly within the framework of the established system of protected areas. Apart from ca. 170 nature reserves designed specifically to protect mires, there is a considerable number of areas established for protection of other elements of nature, where mires play also an important role. The major part of peatland nature reserves (ca. 84 %) is devoted to protection of fens, on the other hand the strict protection measures are applied more frequently to raised bogs and transition mire ecosystems (Ilnicki et al., in print). Mires and peatlands constitute also important parts of large scale protection areas in Poland, such as national parks and landscape parks. Some of these areas were established especially, or in large part, to protect extensive peatlands and mires. Among the best known are three national parks: the Biebrzański NP, Poleski NP and Slowiński NP. The developing network of Natura 2000 habitat sites will supplement the system of protected peatland and mire areas to a large extent. The common feature of all three el-

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Tab. 3a: Major threats and optimal protection measures for mire habitats in Poland – bogs

Habitat type, subtype and Natura 2000 code	Status and type of threat	Proposed methods of protection
Active raised bogs *7110	One of the most endangered mire habitats in Poland. It is estimated that their present area is less than 1% of the original state. Apart from anthropogenic reasons the disappearance of peat-forming bog vegetation may be caused by natural climatical factors. It could concern especially the Baltic raised bogs which in Poland reach the southern limit of distribution.	
Lowland raised bogs *7110-1	For more than 200 years all Baltic rised bogs have been brought gradually into forestry and peat exploitation or at least drained. Probably the same concerns the continental bogs. Relatively better preserved are small raised bogs which developed in depressions without runoff or in bays of lakeswhich have been terrestrialized and separated from the influence of ground- and lake water. Generally condition of bogs situated within the state forest area seems to be better than those occurring in agricultural landscape.	Slightly degenered phytocoenoses represent a suboptimal state. They are still rich in characteristic species, the water level is lowered not more than 50 cm, and temporarily, during a summer, it can even rise close to the surface. Such places are the most promising for the restoration of the peatforming process. All the bogs in good shape should be legally protected.
Sudetes raised bogs *7110-2	Nowadays, all mires in the large basins are gone, due to settlement which started in the middle ages. Large mountain bog complexes are divided by Polish-Czech state border. The human induced changes result from drainage, air pollution, fertilizing and liming of forests. Trampling, forest works, the presence of large game populations, etc. increase the danger of surface erosion in mires.	Legal protection of all bogs retained in good condition and promotion of spontaneous development, control of cachment management (esp. forest management). Restoration of slightly damaged mires by improving water conditions and stopping the erosion. In some cases removal of previously introduced infrastructure is necessary. Need for integrated protection efforts across the state border.
***Carpathian raised* bogs*7110-3**	*The situation of bogs in the Orawa–Nowy Targ Basin is* critical,their total area decreased to 34% of their original size. Some bogs have been destroyed through adaptation to an industrial exploitation, which still continues in one object. Other Carpathian bogs remain practically unchanged. Those situated within the boundaries of national parks (the Babia Góra, the Tatras, partly the Bieszczady) are not threatened.	*A single nature reserve ("Bór na Czerwonem")* exists. There is a need to buy-out, protect and restore the remaining bogs.
Degenered raised bogs still capable of 7120-1	Very endangered across the country because of historical and forgoing drainage natural regeneration of raised bogs for forestry and peat excavation. Habitat very sensitive to progressive lowering of water level, afforestation, peat excavation,burning and trampling. Potential threats, but not recognized sufficiently, can be eutrophication from the air and climate changes (true raised bogs in Poland reach their climatically determined southern limit of distribution).	The only way of their preservation is restoration by rising of the water level. It can be reached by constuction of dams across ditches and removal of trees. In some cases the implantation of peatforming vegetation is needed. Activities should be preceded by recognition of water conditions to plan properly the number, localization and density of dams. Sites should be legally protected by using different forms existing in Polish legislation. The best ones should become nature reserves.

ements of this system is an obligatory need to produce and implement a management plan for each of the mire ecosystem existing within their borders.

The work performed during the implementation period of Natura 2000 system in Poland for the first time has given the oportunity to summarise the existing knowledge about needs and methods of protection of all important mire habitats in Poland. The data, contained in a „Handbook for protection of Natura 2000 habitats" (HERBICH 2004) are ment for a general application by site managers and the general public. Tab. 3 summarises these informations in correspondence to major threats recognised for Polish mires. The future of Polish mires is not entirely bright. Different aspects of the present and anticipated situation of mires and peatlands in Poland have recently been brought up in a number of publications (e.g. WOLEJKO & JASNOWSKA 2004).

With the recent enlargement of the European Union, mire resources that are still preserved in Poland, have to be seen from totally new perspective. The percentage of mires which are still in relatively good state of preservation, estimated to ca. 15 %, has to be wieved as an Europaean asset, especially in respect of mire habitats representative for central Europe. The special importance of still living mire ecosystems in Poland, and to a lesser extent in other "new

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Tab. 3b: Major threats and optimal protection measures for mire habitats in Poland – transition and quaging mires

Habitat type, subtype and Natura 2000 code	Status and type of threat	Proposed methods of protection
Lowland transition and quaging mires 7140-1	The habitat is disappearing due to: previous and present drainage for forestry and grassland management, 2) eutrophying wash-outs in the agricultural landscape, 3) local pollution from households, 4) attempts to increase fertility of oligotrohic lakes for fish production, 5) covering with rubble and other wastes in the surroundings of recreational localities. The transition mires are relatively well preserved in forested areas, however even there there is some transformation for forest cultivation. No reliable data on current status exist, due to lack of systematic surveys. The negative changes include the „settling down" of the floating mats due to lowering of water level, development of small cliffs or banks at the border between a bog peat and the mat, encroachment of trees, development of *Eriophorum vaginatum* tussocks, total destruction of floating *Sphagnum* mire as a result of liming and fertilising of the oligotrophic lake.	The basic and optimal method of protection is a preservation of natural water level, or in case of it's previous lowering – rising it up to original position. A hydrological analysis of the whole wetland complex is obligatory. Measures aiming at reestablishing of proper hydrological conditions, such as filling-in of drainage ditches, damming etc. should be introduced gradually, to allow the system adjustment to new conditions. In places open to educational or touristic activities of for fishing an establishment of wooden paths or bridges is necessary to avoid trampling. For mires situated in agricultural landscape a belt several metres wide should be excluded from plowing. Instead a meadow on mineral soil could be introduced, which is acommon practice in traditional agriculture (e.g. in the Kashubian region). In forested landscapes the clearcuts should be excluded in the vicinity of transition mires, and no branches should be dumped on the mire surface. Any pollution with rubble, wastes as well as radical change of land use (for example for fisheries) should be prohibited. The habitat is legally protected in the Drawa National Park, Tucholskie Woods N.P., Wigry N.P., several nature reserves, some of them situated in the Landscape Parks. In most cases only the passive protection is applied. Individual examples of active protection, mostly by blocking the outflow and gradual rise in water level, are found in the reserves Leśne Oczko, Kurze Grzedy and Jeziorka Chośnickie.
Mountain transition and quaging mires 7140-2	The hydrological system for the most part of the areal of mountain mires in the Sudety Mts. is severly disturbed as a result of previous drainage and the present-day disaster caused by acid rains. The latter have contributed to hydrological changes by massive destruction of mountain spruce forests. As a consequence upper peat layers have been dessicated, mire species were substituted by such species as *Deschampsia flexuosa*, *Molinia caerulea* and *Calamagrostis villosa*. Reduction of the pollution seems to progress well, however the full regeneration of mire vegetation will take a very long time. The potential threat for mires is liming and fertilizing of adjacent forests and areas planned for afforestation.	Protection of transition mires in the mountains is determind by the special position occupied by these mires within a local catchment and in the spatial complexes with other mire types. Protection of living mountain bogs in Bieszczady, Tatra and Sudety Mts. and in Podhale guarantees protection of associated transition mires. There is also a need to extend legal protection to all well preserved transition mire areas existing in the lower and upper mountain belt of the Izera Mts., Karkonosze, and other mountain chains in Sudety. Each selected area should have a buffer zone to guarantee the natural alimentation of water and stabilisation of other ecological parametres (trophy, pH etc.). For the remaining peat deposits (both open and forrested) the rules of management should be established, aiming at preservation of proper environmental conditions.

Tab. 3c: Major threats and optimal protection measures for mire habitats in Poland – Depressions on peat substrates (*Rhynchosporion*)

Habitat type, subtype and Natura 2000 code	Status and type of threat	Proposed methods of protection
Depressions on peat substrates (*Rhynchosporion*) 7150	The localities of the habitats always form a part of spatial complexes of raised bogs or wet heathlands, thus undergo all negative changes typical for those ecosystems. Total area occupied by the habitat in the country is very small, and thus they are severely threatened.	Passive protection is recommended for localities occurring in naturally formed depressions on mire surface. In unprotected interdune depression (both coastal and inland) there is a possibility of opening of spaces in the adjacent and ecologically associated ecosystems and than allowing spontaneous succession. Similar approach should be applied in wet heathlands in coastal zone. Sites situated on lake shores have to be excluded from touristic and recreational pressure. The general rules of protection of sites from dessication, eutrophication and chemical pollution have to be respected. Passive protection has been applied in some nature reserves e.g. „Bialogóra", „Bielawa" and „Janiewickie Bagno". Such protection should also be applied if habitat's existence in the Slowiński and Karkonoski National Parks and in the "Mierzeja Sarbska" nature reserve is confirmed.

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Tab. 3d: Major threats and optimal protection measures for mire habitats in Poland – fens.

Habitat type, subtype and Natura 2000 code	Status and type of threat	Proposed methods of protection
Lake-chalk mires *7210	It has been estimated than more than half of the original areal of *Cladium* vegetation has been destroyed. They are threatened by: – withdrawal of *Cladium* vegetation in reaction to lowering of water level or burning; – fluctuations, in case of irregular mowing; – degeneration (thinning out of sward, invasion of *Molinia caerulea* and *Calamagrostis epigeios);* – transformation of communities into moss/meadow vegetation; on very dry spots to calciphilous dry grasslands; – transformation of rushes into wet alderwood; – invasion of synanthropic species.	The protection methods depend from the dynamic state of vegetation, which, in turn results from the stable or disturbed abiotic conditions. These are mainly hydrological and trophic conditions and the direct human impact on phytocoenoses. In part of localities, especially at lake-side sites which are in hydrodynamic equilibrium, a passive protection is sufficient. In all other cases active management is necessary. Most often it is a stabilisation or rising of water level, or extensive use of the sites (mowing and grazing) which prevents the succession towards the shrub and forest communities. The protection methods have to be customised in relation to individual properties of sites. They should be based on good knowledge about origin and dynamic state of phytocoenoses in association with 1) the direction and speed of natural processes, and 2) causes, types and intensity of human induced changes in vegetation. Due to the landscape position of the habitat in the vicinity of lakes, there is a need for large scale stabilisation of hydrological conditions. For example in outflows from through-flow lakes permanent dams should be built. Lake-chalk mires are protected in several nature reserves e.g: „Tchórzyno" in Myslibórz Lakeland, "Durne Bagno", "Krowie Bagno", "Miranowo", "Bagno Serebryskie", "Brzezno" and "Roskosz" in the Chelm Landscape Park, Drawa National Park, and Wigry N.P but the number and regional representation of site is far from optimal.
"Mountain flushes" 7230-1	Very sensitive to permanent lowering of water level, and to intensive trampling by animals.	The optimal way of their preservation is continuation of traditional use as extensive grasslands. Some examples of this habitat are protected in Tatra National Park, Pieniny N.P. and Gorce N.P.
Upland basiphilous mires of southern Poland 7230-2	Extremely endangered across the country due to general and wide-scale disturbance in water conditions. In situations where dynamic equilibrium is achieved by traditional management the major threat is abandonment of mowing. Within intensive agricultural landscape chemical pollution leading to eutrophication is a serious threat. Serious protection mistakes due to abandonment of traditional use are well documented in a number of nature reserves.	Preservation or restoration of hydrological conditions with simultanous traditional mangement (mowing or light grazing). In better preserved cupola fens mangement by qualified personel only. Management should be adjusted to individual objects, considering the genesis and the dynamic state of phytocoenoses, directions and speed of changes in abiotic conditions. Formal protection is realised in several nature reserves in the landscape parks in the vicinity of Chelm and Lodz and in the singular reserves in Wielkopolska and Lower Silesia.
Spring- and percolating mires of northern Poland 7230-3	On the country scale there is a major decrease in the area of the habitat (reasons as above – see 7230-2). The serious threat is the widespread construction of fish ponds and other water reservoirs. In some places obstructions to the outflow of rainwater lead to acidification of mire surface and the expansion of trivial *Sphagnum* species (e.g. *S. fallax*). New threats arise from large scale development projects (Via Baltica; large river regulation and canalisation projects; water reservoirs).	Preservation or restoration of hydrological conditions with simultanous traditional mangement (mowing or light grazing). On wet sloping mires methods of curbing succession should be applied by qualified personnel. From the little sloping fens an excess of rainwater should be removed by network of very shallow surface drains. More severely drained mires should be restored by blocking ditches on slopes and rising the "erosion base". Promoting the activity of widelife resulting in "opening" of dense vegetation and restoring conditions for pioneer biota. Very large mire areas (e.g. Biebrza and Narew) demand integrated management plans (combining rational water management, agricultural activities, hunting etc.). Active management takes place in several nature protection areas, e.g.: Wigry N.P.; Biebrza N.P.; Drawa N.P.; Slupia Valley Landscape Park; Barlinek-Gorzów L.P.; Pliszka Valley nature reserve. Periodically mown, not fertilised phytocoenoses retain their composition and structure. Certain intermediate successional stages of sub-optimal soligenous mires (tall-forb and tussocky sedge communities) may deserve protection.

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members" of the EU, is obvious when the above figures are confronted with the situation of several "old member" countries, such as Belgium, the Netherlands, Germany or Denmark, where estimated loss of living mire ecosystems have exceeded 99 %. In this respect Polish mires constitute a refuge of rare biota (and their possible source for restitution projects on international scale) as well as the base for scientific studies on ecological processes essential for restoration.

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Zusammenfassung

Typologische Differenzierung und Status der Natura 2000 Moorgebiete in Polen – Dieser Artikel stellt die verschiedenen Moortypen und den Status der Natura 2000 Moorgebiete in Polen vor. Trotz der in der EU-Anleitung von 1996 gegebenen allgemeingültigen Definitionen und Interpretationen gibt es in den verschiedenen Mitgliedsstaaten eine gewisse Freiheit, wie die konkreten Lebensräume wirklich zu verstehen und zuzuordnen sind. Unter den 76 Natura 2000 Lebensraumtypen, die Polen nominiert hat (HERBICH 2004), gibt es insgesamt sechs, die sich auf lebende Moore beziehen: wachsende Hochmoore, degradierte Hochmoore, die noch regenerierbar sind, Übergangsmoore und Schwingmoore, Schlenken über Torf, Moore auf Seekreide und basenreiche Niedermoore. All diese Moortypen wurden im Hinblick auf geographische Verbreitung in Polen, ökologische Eigenart, Vegetationsdynamik, Schutzstatus und Schutzbedarf charakterisiert. Die Implementierung des Natura 2000 Netzwerks brachte neue Chancen für die Moore Polens, denn im Interesse der Europäischen Gemeinschaft erhielen sie unabhängig von ihrer Anzahl und Lage einen Schutzstatus. Darüberhinaus zeigte diese letzte Moorerhebung auch, dass der Zustand der Moore in Polen besser zu sein scheint als in vielen anderen mitteleuropäischen Ländern – insbesondere wenn man die Quantitäten betrachtet. Trotzdem gibt es in zahlreichen Fällen dringenden Handlungsbedarf zur Anwendung aktiver Schutzpraktiken, die einerseits auf gründlichen Erhebungen, andererseits auf (hydro-)ökologischen Untersuchungen basieren.

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